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DIFFERENT TYPES OF RED CLOVER*

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[Translator: R. PETER JONES]

When one speaks of different types of red clover, in general different types of earliness are meant. This is very natural as the time of development in the first place is a distinct character and in the second place frequently has a certain connexion with cultivation value. Thus many Swedish farmers think that early red clover is the same as foreign, while late clover denotes Swedish origin. The matter is, however, not so simple, as both early and late red clover can be obtained from abroad, and both are grown for seed in Sweden. In the seed trade and in the literature relating to seed production and the trade in seed it has, however, been usual to designate as early clover the type which can be counted on to give two hay cuts and therefore by the Germans named " zweischnittig " and in English given the corresponding name " two-cut." The so-called late red clover, which when cut during the period of flowering as a rule does not yield flowering aftermath, and therefore is rarely harvested as hay more than once a year, is designated in contrast to the early as "einschnittig" in German and "single-cut" in English. Unfortunately we have no corresponding Swedish designations but "schlesisk" (Silesian) and "late" have become the accepted terms. The former name has an historical explanation and can be traced back to the time when of foreign red clover Silesian was considered to be the best, and all foreign red clover for that reason was called Silesian. It is nevertheless very unsuitable, firstly, because foreign red clover in recent years has in general come from Poland and secondly, because seed production of early red clover has been instituted to quite a large extent in Sweden, and such clover should not be given a foreign name particularly as early Swedish strains are available.

In addition to the two types mentioned medium-late red clover has recently become better known and more highly valued since red clover seed production in Scania has developed to such an extent that the seed grown in the province has come to play an important part in the seed trade. Thus nowadays medium-late Swedish red clover is included in the quotations of the Swedish Seed Growers' Union, but on the contrary quotations for early red clover and various strains for different agricultural areas of the country are still lacking.

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*NILSSON, F. Olika typer av rödklöver. [Different types of red clover.] *Svensk Frötidning*. 8. 130-3. 1939.

It can, however, not be disputed that the designations mentioned, early, medium-late and late red clover, broadly speaking satisfy the south Swedish farmers' desire for information as to type of clover. For the initiated the problem is more complicated, and for those who have to advise farmers about the most suitable clover type or clover strain for a certain area, or whose task it is to test the genuineness of a certain lot of seed, it may frequently be difficult to arrive at a correct decision. It may be stated in passing that the degree of earliness is no guarantee of cultivation value in itself but only indicates which type is in question.

The different red clover types are, however, not so sharply delimited from one another as might perhaps from certain points of view be considered desirable, but on the contrary there are many gradations of *inter alia* earliness. Further, a certain degree of earliness is not some fixed and unchangeable, easily determinable character, but constitutes an average of earliness in all the types included in a certain lot of seed or rather a certain strain, which will be treated in somewhat greater detail. First it will, however, be emphasized that the time of flowering certainly very frequently, but not always, is an adequate expression of earliness, whereby one more correctly means the time when the respective strain or clover type attains a suitable stage of development for cutting, which should coincide with the maximum production of digestible nutrients. Parallelism between suitable harvesting stage and beginning of flowering certainly is very great, but exceptions occur however, and as an example the Wambåsa strain may be mentioned. This develops early to the cutting stage both in the main crop and the aftermath without developing flowers in a corresponding degree. As this behaviour is, however, not usual, we will not discuss it further, but will confine ourselves to the types which can be arranged according to the time of flowering.

The question is by no means new but has become of special interest since the guarantee for genuineness of type has been included as a part of state sealing of red clover, when the sample taken is subjected to after-control cultivation. It is quite obvious that a farmer who purchases, for example, medium-late red clover would wish to have a guarantee that the seed really is medium-late and not late, as this is of importance for the time of cutting and the aftermath reckoned on in the ley. In the same way one would wish to be sure of obtaining genuine late clover of persistent type for long-duration leys, where the medium-late and earlier types frequently do not meet the requirements. Further, the prices may often be so different for early, medium-late and late red clover that the vendor may be tempted to include an admixture of cheaper seed of another type if control were not exercised. The important question is, therefore, both from the vendor's and the purchaser's point of view: to what extent and with what degree of certainty can genuineness of type be determined both absolutely and as regards freedom from admixture of another type?

As early as 1909 Witte pointed out (*Sveriges Utsädesförenings Tidskrift* Vol. 19. p. 56) that quite considerable differences could be established in development in Swedish clover strains and that transitions existed from the latest of all to the earliest of all. He considered, however, that a grouping should be made into late, early and medium-early strains, which grouping was afterwards used in a report on strain

trials with red clover. In addition to the types of earliness named, mention is also made of very late strains, but they are grouped together with the late. In subsequent works too Witte distinguishes different types of earliness.

In an investigation on the number of internodes in different types of earliness of red clover, Elofson (*Svenska Betes-och Vallföreningens Årsskrift*, 1930) endeavoured to find other characters which could be estimated to be connected with time of development, so that by observation directly and without comparison between different types it would be possible to determine which type of earliness one had to deal with. There can scarcely be any doubt about such a connexion between earliness and length of internodes according to that investigation, but in view of the variation it is difficult to make practical use of the method.

In an address during Agricultural Week (*Lantbruksveckans Handlingar*, 1931), the writer illustrated by means of notes on an extensive material the variation in earliness in a large number of strains of foreign and indigenous origin. As a certain discontinuity had been traced, a classification into early, medium-early and late red clover was proposed, which was considered to cover the material in question. With the additional experience gained subsequently, firstly, from more strains and types, and secondly, at different places in the country, the author now considers himself to be in a position to supplement and partially correct the pronouncements then made. All transitions are found between very early and very late red clover, and a classification into different types of earliness must therefore be of a purely conventional character. Nevertheless, it may be justifiable to make a classification using so many groups that all existing types can be placed in position and defined. As to the types which come into question in Sweden, it is easy to distinguish between the early and the late, but all the types which lie between them can be the subject of discussion, particularly as in them earliness can be dislocated by production of seed at different places or by different seed production technique, as has been pointed out by Hellbo. Further, it should be emphasized that a difference in earliness of nearly a week in Scania can be almost completely levelled out by cultivation in Norrland. In this connexion I would also mention that the Norrland type of red clover cannot be assigned a place in any one of the types of earliness discussed by Hellbo. It is as early in development as the medium-late clover or even slightly earlier as regards time of flowering, but yields a very poor aftermath and is in this respect, despite its early flowering, a pure "single-cut" type. This Norrland type of clover is unique and has acquired its special adaptation to the Norrland climate, which involves a long period of rest which sets in early in the autumn with hardening for the winter. Its manner of growth is also quite characteristic.

As long as one keeps to the three types, early, medium-late and late red clover, and has to do with only one strain of each, it is fairly easy in controlled cultivation to decide to which a certain seed lot is to be referred. If on the other hand one has to deal with ten strains with degrees of earliness varying from early to medium-late or from medium-late to late it will be much more difficult to decide whether a certain lot of seed is to be designated as true to type or not. The Danish strain

Tystofte no. 40 may be cited as an example. According to observations it has been found to possess a degree of earliness which lies midway between early, Polish red clover and Scanian, medium-late red clover. The average figure during one year was for a large number of individual plants six days later than in the early clover and ten days earlier than in the medium-late Harrie strain. Another example is a Västergötland strain, which during the same year flowered on the average eight days later than the Harrie strain and six days earlier than the typical late clover from Ultuna.

In addition to the difficulties mentioned, variation occurs within the individual strains. As a cross-fertilizing plant it is difficult to obtain red clover which is completely homogeneous, although pure-breeding of the type is of course to a certain degree possible. As long as we employ local strains and mixed seed lots of these strains to a large extent, we must, however, reckon on considerable variation, which very seriously hampers the fixing of a certain type and renders almost impossible the determination of admixtures. The accompanying diagrams illustrate the variation in flowering of some strains. In diagram 1 are included three strains of the three "standard types" early, medium-late and late, and diagram 2 indicates the flowering of three other strains, which do not rightly fit into the system. To which group these are to be referred it is therefore difficult to decide. From the diagram it is also seen that a certain percentage of aberrant plants normally occur within the strains and are therefore not to be regarded as admixtures, although they cannot be said to belong to "the type." Thus in the estimation of admixtures very great care must be observed, and unless the strain in question has first been accurately investigated and described, the content of normally occurring divergent types of earliness cannot be determined.

The problem is a very complicated one and calls for further investigation with close study of the same strains in different localities. Meanwhile in the classification of the red clover strains into groups according to earliness it will probably be convenient to have the intermediate types represented by separate groups, and instead of three groups of earliness it appears to be necessary to set up at least five, namely, early, medium-early, medium-late and late and also the Norrland type.

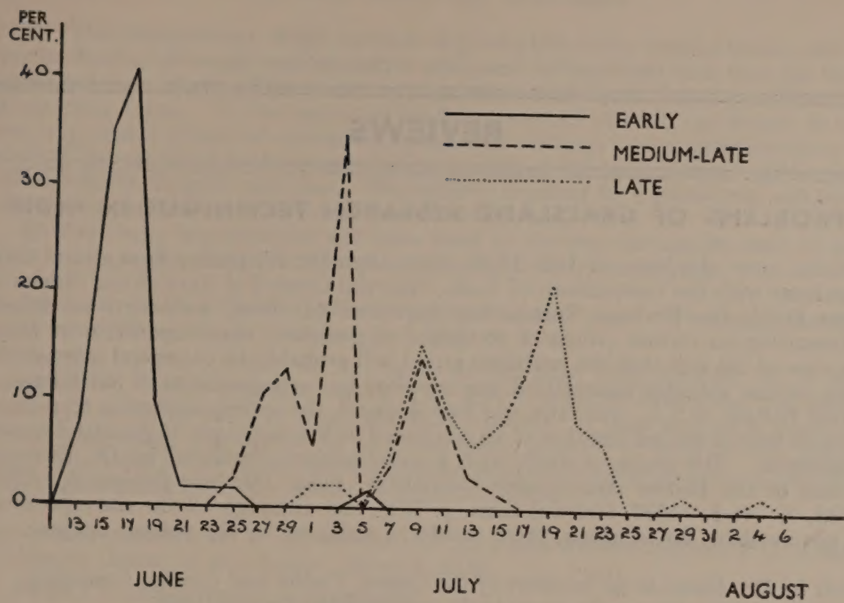


DIAGRAM 1

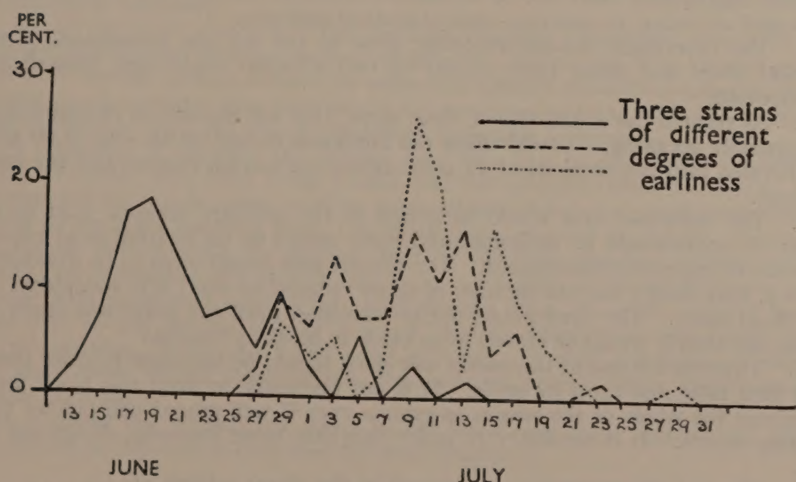


DIAGRAM 2

REVIEWS

PROBLEMS OF GRASSLAND RESEARCH TECHNIQUE IN INDIA

UNDER cover of a letter of June 19/20, 1939, from Dr. W. Burns, Agricultural Commissioner with the Government of India, Imperial Council of Agricultural Research, New Delhi, the Herbage Bureau was requested to obtain comments or definite information on certain points of technique of grassland experimentation in India. In view of the fact that the problems raised will probably be of general interest and that certain valuable information was supplied by correspondents of the Bureau in Great Britain, U.S.A., Australia and New Zealand, the correspondence is reproduced here in full for the information of all concerned in the technique of grassland experimentation. The sequence starts with a memorandum circulated by Dr. Burns on behalf of the Fodder and Grazing Committee, India, (*Herbage Reviews* 6. 122-3. 1938, 7. 41-3. 1939, and this issue, p. 104), and although all the correspondence is not available for inclusion, there should be sufficient for the present purpose.

Note by Dr. Burns to the members of the Central Fodder and Grazing Committee.
Outline for an experiment in the improvement of grazing land.

1. It is desirable that such an experiment should not only give results as to the value of the treatment given, but should be a demonstration plot for visitors. Statistical significance need not be attempted, but such sampling as is done should be arranged according to common-sense statistical methods.

2. The experiment should definitely show to the eye the advantages of the treatment given and hence there should be two adjacent areas—one treated and one untreated.

3. As regards the actual size of these areas, this will depend on circumstances. But, generally speaking, I should think the minimum should be an area of 40 acres to be divided into two sections of 20 acres each—one section treated and the other untreated.

4. The untreated area would be grazed in the ordinary manner, that is, the number of cattle would be unlimited and there would be no restriction as regards their time of entry or of movement. The treated area would have to be divided up into, say, four blocks and the number of cattle reduced to what it is considered the area would carry. The herd would not be admitted until the grass was ready for grazing and then it would be moved from block to block as required.

5. Towards the end of the season one block should be left aside in order that it might seed fully and drop its seeds. It is not necessary to keep this block intact throughout the whole of the season as grasses even if well grazed will put up their flowering shoots. It is necessary to make sure that these flowering shoots are not eaten.

6. The only improvements mentioned in the above scheme are :—

(1) reduction of cattle,

(2) delayed and rotational grazing.

It is open to any Province or State to add to these hay-making, silo making, conservation of manure, utilization of rock salt, reseeding, weighment of cattle, etc.

7. The measurement of the increase of grass yield in the treated blocks can be done by fencing off small random sample plots and cutting them each time the herd is admitted to a block. This is not perhaps very satisfactory, but it is difficult to get anything better. In the untreated block an estimate of yield can be got in the same way, and it would be convenient to take the cuttings in the untreated area in the same time as those in the corresponding portion of the treated area. All sample plots should be changed each year. The number required for a given area will have to be worked out in consultation with the statistician.

Qualitatively, improvement will show itself in the way the species alter, in the denser cover, and in the greater carrying capacity of the treated plots.

Letter from Dr. Burns to Dr. R. O. Whyte, Deputy Director, Imperial Bureau of Pastures and Forage Crops, Aberystwyth. May 26, 1938.

I enclose copy of a letter No. 213 dated the 2nd May, 1938, from Mr. W. D. M. Warren, I.F.S., Forest Research Officer, P.O. Hinoo, Ranchi, Bihar, and my reply No. D.O. F.18 (5)/38-A.H. of May 6th, 1938, thereto. I also enclose a copy of my note on grazing experiments to which he refers (above). I shall be very much obliged if you will let me have your suggestions as to the number and size of samples which should be taken in the case of an experiment like this.

Copy of letter from Mr. W. D. M. Warren, I.F.S., Forest Research Officer, P.O. Hinoo Ranchi, Bihar, to Dr. Burns. May 2, 1938.

Subject :—Improvement of grasslands.

1. I have the honour to state that a copy of letter No. F 18 (5) 38-A.R., dated the 4th February, 1938, from the Imperial Council of Agricultural Research, with enclosures, has been sent to the Conservator of Forests, Bihar, for such action as may be considered necessary.

2. In your note attached to that letter you suggest a minimum area of 40 acres be taken, and divided into two sections of 20 acres, one section to be treated and the other not, the one section to have an unlimited number of cattle grazing on it, and the other to be divided into four blocks for rotational grazing with the number of cattle reduced to what the area is considered to be able to carry.

3. Instead of dividing the treated area into four blocks, would it suffice to divide into three, each block being 5 acres, and the untreated block 15 acres? I ask this question because in recent working plans we have drawn up schemes for rotational grazing on the three-monthly basis. In those plans, in order to simplify administration, we are only rotating the grazing areas for the three monsoon months of July, August and September, but there might be an advantage in having duplicate areas, the one with rotational grazing for three months only, the other rotated for the whole year as you suggest in your schemes, and to compare the grass yield under the two systems. From the forest point of view, our chief anxiety is to ensure a good grass cover on hill slopes during the monsoon months, when erosion damage is at its maximum.

4. Would the Statistician please let me know how many randomized sample plots would be required in each area for each rotation?

Letter from Dr. Burns to Mr. W. D. M. Warren. May 26, 1938.

This is in continuation of my D.O. F.18 (5) 38-A.H., of May 6th, 1938, in reply to your letter No. 213 of May 2nd, 1938. There is no objection to your dividing the area into three blocks, each block being 5 acres and the untreated blocks 15 acres. Nor is there any objection to your rotating the grazing areas for the three monsoon

months—July, August and September only. I do not think there is any need to have an area rotated for the whole year. In fact, I had not intended to suggest this in the scheme. My outline really is intended to deal only with grazing during the rain months, although I have not made this very clear.

Regarding the number of randomized sample plots required in each area for rotation, I am afraid that we have not got any accurate experimental data to give a clear guide on this matter and your experiment, with others, will be a means of providing a certain amount of data for India. I had discussed the matter with the Statistician, who suggests that in a block 3.75 acres there should be a minimum of 20 random samples of 400 sq. ft. each covering 5 per cent of the area. I am afraid that this is rather an impracticable proportion and I feel that for the present we must be content with samples of very much smaller percentage of the area. A recent article by Hoffman, R., Kirsch, W., and Jantzon, H., " On the technique of determining the yield of permanent pastures", (see *Herb. Abstr.* 8. Abs. 38. 1938), records the utilization of twenty-five plots, each 4 sq. m. in size, distributed at regular intervals over 13 hectares in one experiment and twenty-four plots each of 11 sq. m. in a 12-hectare area in another experiment. I think we might try four times the number of plots in the second experiment (that is, 24 plots to a 12-hectare pasture) that is, making it ninety-six plots per 12-hectare pasture or eight plots per hectare (2.5 acres, or say three plots per acre). The size of each plot should, I suggest, be 100 square feet (10 ft. × 10 ft.).

I am sending a copy of this correspondence to the Imperial Bureau of Pastures and Forage Crops, Aberystwyth, for their further advice in the matter which I hope will be received in time to be of use to you. It is quite possible that they may have something which may be more scientific and practicable to suggest and hence it might be wise not to lay out these plots until you hear further what the Imperial Bureau has to recommend.

Letter from Dr. Burns to Dr. Whyte. June 19/20, 1939.

The enclosed letter from Laurie indicates the kind of problem we are up against in this country. I shall be much obliged for your advice.

Copy of letter from Mr. M. V. Laurie, Silviculturist, Forest Research Institute and College, Dehra Dun (New Forest P.O.), to Dr. Burns. June 17, 1939.

I have been in correspondence with the Forest Research Officer, Bihar, Ranchi, regarding comparative experiments to test the effect of rotational grazing on pasture yields, and I note that Mr. Warren has also written to you on the subject. He has sent me copies of your replies Nos. 213, dated the 2nd May, 1938, and F.18 (5) 38-A.H., dated the 6th May, 1938. Similar experiments are being attempted by the Silviculturist of the Central Provinces and we are still in difficulties about the technique to adopt.

In the Bihar experiment under discussion the problem is to compare the effect of two treatments, namely :—

(a) Continuous grazing throughout the year, and
(b) Monthly rotational grazing during the monsoon months, combined with continuous grazing during the rest of the year,

on the yield of the grass and hence the grazing capacity of the area in terms of the number of cattle it will support per acre. I have looked up all the literature available in my office, and have particularly referred to Bulletins Nos. 11 and 14 of the Herbage Publication Series which you mentioned, but I could find no indication of how one can determine grass yields under differential grazing treatments. The nearest

approach to a similar subject is given in Bull. No. 11, page 22, where the effect of different fertilizers on grass production was being tested and yields were determined by a technique of alternate mowing and grazing. This, however, is fundamentally a different problem as the variables that are being compared are manurial treatments and are not directly concerned with the grazing. Later in the same article there is a section on the technique of stock grazing trials (page 31) to which you have referred, but this also does not help us because results in this case were determined solely by the effect of different methods of grazing on the liveweight increase, wool production, etc., of the animals. No attempt was made to determine the effect on the yield of herbage.

Under forestry conditions it is quite impossible, as you will realise, to attempt to assess results of rotational grazing on the basis of the effect on the weight, milk production, etc., of the cattle and the only other alternative is to get an estimate of grass yields. I write to enquire whether you can help me in this by referring me to any technique that has been found satisfactory for estimating grass yields in plots which are under grazing. Naturally, the animals eat part of the grass and the amount eaten may vary from one treatment to another, in spite of having comparable cattle in each treatment. Any substitution of artificial cutting in place of grazing has the disadvantage that the effects of trampling, manuring, and selective grazing of the animal on different species are not simulated by any artificial cutting method. I would be very grateful if you could suggest a way out of this difficulty.

Another point on which I would like your opinion is in the matter of lay-out. You have suggested in your letter quoted above a single area of 40 acres to be taken and that this should be divided into 2 sections of 20 acres, one of these sections to be used for rotational grazing in smaller fenced paddocks while the other is to be continuously grazed. In a large experiment which was done in the Central Provinces on the effect of long-term closures on grass production in which grass yields were determined by cutting from a large number of replicated plots, it was found that the variations in yield from cut plots classified as similar on the basis of soil, slope, drainage, botanical composition of grasses, etc., amounted to anything up to 500 per cent. It appears, therefore, that considerable replication of treatments is necessary. Even in experiments in sown pastures on flat uniform land (*vide* figure 8 in Bull. No. 11), 4 to 6 replications were found necessary, and wherever the ground is not so regular 8 to 12 replications were suggested as being desirable to reduce the errors due to fertility variation. In natural forest pastures, not only is there a very much greater variability due to differences in soil fertility, but also very considerable variation in the composition of the grass flora is found from place to place. It would appear, therefore, that any investigation involving determination of grass yields either quantitatively or qualitatively, or both, would necessitate an impossibly large number of replications if any results of value are to be obtained. I would welcome your opinion on this point and also upon the possibility of obtaining satisfactory initial comparability by preliminary uniformity trials carried over one or two seasons before the differential treatments are applied. As already mentioned, the objects of such experiments are to determine (1) the effect of the different treatments on the composition of the grass flora, and (2) the production by weight of the different species. I have a feeling that we are attempting the impossible when we set out to determine quantitative effects of such treatments under natural pasture conditions owing to the enormous variations that are experienced. I would welcome any suggestions you may be able to offer regarding this most important subject. The Congress Ministries are laying great stress upon the necessity for improving the grazing capacity of our forest grasslands and are making available a considerable amount of money for grassland research. It is necessary that any money so spent

should be properly applied and not wasted in unproductive experiments. The problem seems to me a very difficult one and any help that you can give us will be greatly appreciated.

Comments by Mr. William Davies, Welsh Plant Breeding Station, regarding points raised in above letter from M. V. Laurie.

A.—Technique

I would suggest the use of strong movable cages which could be driven into the ground, and which would require to be built sufficiently strong to withstand damage by grazing cattle. In sheep experiments we use (and the Australians have used) cages with internal measurements of one square yard. For Indian forest-steppe conditions the cages might have to be larger. The procedure adopted in order to arrive at yield of herbage is to take periodical cuts within the cages and to move the cage to a new site after each cut. The accuracy of such yields will depend upon the number of cages per unit area. The minimum required on a statistical basis is about fifty cages per plot, but in practice this figure is well above the maximum which can be dealt with conveniently. I would suggest in India about 5 to 10 per plot should be tried in order to see how the figures work out. It is important that the cage be moved to a new site after each cut, and also that a " clearing cut " be made on the new site to remove all uneaten growth, and in order to discover the amount actually grown during the period that the cage is *in situ.* An even better method is to take the so-called " clearing cut " on a separate area as nearly similar to the caged area as possible. The difference in yield between the " clearing cut " and the cut made *later* within the cage would represent the amount of growth made during the caged period. The above remarks all presuppose reasonable uniformity within the experimental blocks. If the blocks are very non-uniform, the number of cages, that is, the number of samples ought to be increased and distributed over as many types as occur within the experimental block.

B.—Lay-out

With regard to the lay-out, I doubt if I can offer really concrete suggestions—it would be almost impossible to do so unless one were on the spot. As a general thesis it is better always to work from the general to the specific, by which one means to aim first at obtaining the large real differences, which in turn means that at the start one can deal with non-replicated, or at most triplicated, plots. At later stages, when smaller differences are being investigated, greater replication and perhaps smaller plots would become necessary.

Copy of letter from Dr. W. R. Chapline, Chief, Division of Range Research, U.S. Forest Service, Washington, D.C., to Dr. Burns. August 17, 1939.

Dr. R. O. Whyte, Deputy Director of the Imperial Bureau of Pastures and Forage Crops, has transmitted to me copies of your correspondence with specialists in India concerning the matter of lay-out and technique of proposed rotational grazing and pasture yield experiments in India. Dr. Whyte suggested that I send you direct any comments that I may have. The correspondence has reached me in the field, but rather than delay my reply I will send you my comments based on such material that I have at hand.

Inasmuch as I am not wholly familiar with the type of grassland and range with which you are concerned, perhaps outlining some of our pasture designs, plot techniques, and methods of determining range forage yield may be of some help to you.

The great variability in soil conditions and vegetation on our native ranges in the western parts of the United States requires replications in our pasture lay-outs. We need to have at least duplicate or triplicate pastures under each treatment to afford valid basis for the determination of the differences between treatments. Where the difference expected may be large and clear-cut, the need for replications is not great and in some of these instances factorial lay-outs are used. However, where the results expected may not be large or there may be difficulties in measuring the vegetative response, replications of pastures are essential. In instances where replications are physically impossible, that is, where duplicate areas cannot be obtained or the cost is too great to handle, such as in experimental watersheds, switchback lay-outs have been used with success.

In this design the treatments on two pastures, after being run for a given period, are switched or reversed and run for an equal period, affording replication with years. However, you can readily see that such a pasture design is not ideal since climate is confounded. In all these pasture lay-outs, the area of the pastures and the number of livestock used are sufficient to afford results that may be applied to actual range conditions.

Once an effective pasture lay-out that will satisfy the conditions of the problem is established, measurement of the vegetative response under the various grazing treatments is obtained through plot measurement; the thoroughness of measurement being in direct relationship to the adequacy of the plot technique used.

The type and size of plots we use depends upon the type of vegetation with which we work and the character of record which seems most appropriate to answer the problem at hand. Moreover, the number of plots employed in our pastures depends upon the variability of the vegetation and soil in the pastures and the accuracy of the sampling desired.

In our western range area we are dealing primarily with perennial bunchgrasses that do not form a complete ground cover. The chief objective in our plot work is to determine the trends of the vegetation, mainly the perennial bunchgrass, but also the other palatable perennial herbs and shrubs present, under the various climatic conditions and grazing use. Of principal use in determining the trends of the bunchgrasses is the chart quadrat, which may vary in size from 1 to 4 square metres depending upon the density of plant cover. In charting the quadrats the basal area of the bunchgrasses, 1 inch from the soil line, is charted by means of a pantograph and thus the trends over the years are recorded.

To supplement the chart quadrats in this perennial type of vegetation, circular sample plots, 100 square feet in area, are employed at random within the pastures. The vegetation on these plots is estimated, ocularly, species by species in terms of square feet of plant cover. Re-estimates each year or every two years of the vegetation on the plots provide additional data on vegetative trends. On some of our mountainous ranges, 500 of these sample plots are necessary within each range unit to yield data accurately within 10 per cent of the mean. For shrubby vegetative cover, additional plots varying from 5×25 feet to 33×33 feet, depending upon the system of mapping on which the position of each shrub and its crown spread is mapped, are used to determine the trend of this type of cover under grazing use. Photographic records are also maintained for visual records.

The general reconnaissance method of range surveys which provide a general inventory of the plant cover and other use data on our national forest ranges as a basis for determining the grazing capacity of the forests, are sometimes used in our pasture work in establishing vegetative type boundaries and furnishing general information as to the type and extent of the vegetative composition of the pastures.

In the annual type of vegetation, characteristic of the foothills of the State of

California, a different plot technique is required. There the great change in plant cover from year to year, due to a large extent to variable rainfall, makes it necessary to use many small plots. Plots 1 square foot in size have proved desirable in studying this complex and changeable annual plant cover. This requires a large number of plots, but these are estimated ocularly as to density of cover, composition and volume, with checks by clipping and weighing.

For measuring forage yield, two general methods are used, namely: (1) Livestock condition, weights, and production; (2) Measurement of the plant cover. The first method is perhaps clear in itself. The second is most commonly attacked in two ways. In one, a system of movable hurdle plots of varying size, usually a rod square, is set up within the pastures or on the range and the forage produced is directly measured from plots within the hurdles in pounds per acre or in some other definite term. Composition of the vegetation is also obtained. Where different seasons of grazing are employed, a series of hurdles is erected season long to measure total yearly production and additional hurdles are erected for specific periods to determine the various seasonal forage production.

The other means of determining forage yield, by the study of the plant cover, is that of directly estimating, ocularly (and checking estimates by clipping and weighing), the forage produced by the individual plant species. This method has been used with success in determining forage yield on our perennial bunchgrass and sagebrush ranges.

I am requesting my secretary to send you, under separate cover, some published and mimeographed articles and instructions concerning our general methods and plot techniques that may be of interest to you. Also, we have just finished a special Forest Service range seminar at which we discussed methods and procedures of our range research in detail. As soon as the proceedings are available, I'll send a copy to you.

Letter from Dr. J. Griffiths Davies, Senior Agrostologist, Council for Scientific and Industrial Research, Division of Plant Industry, Box 109, *P.O., Canberra City, A.C.T., Australia, to Dr. Burns. August* 11, 1939.

Dr. R. O. Whyte, of the Imperial Bureau of Pastures and Forage Crops, has asked me to comment on certain difficulties of pasture technique that you have presented to him for criticism. I have appended my conclusions in the form of a discussion and an experimental layout which is, of course, extremely simple in a statistical sense, but contains a most important principle, that any set of rotationally grazed plots are in fact but one replication. The second important point is that replication should be primarily aimed at replication of blocks and not at replication of samples per plot. In the limit it will be obvious that if one replicate of a treatment is not a good representation of the mean of the population of the treatment, then even if it is sampled with 100 per cent efficiency, the result is no nearer the truth. Again increasing the number of samples per plot does not give a better estimate of error, whereas the same effort of sampling over *more* replications does give a better estimate of error.

Notes on Grazing Technique by Dr. J. Griffiths Davies, Senior Agrostologist.

The problem is:

To compare the effects of two treatments, namely,

1. Continuous grazing throughout the year.
2. Monthly grazing for the three monsoon months;

on

(a) Yield of herbage.
(b) Botanical composition of the herbage.

There are 40 acres, deemed to be variable, available for the experiment.

I am interested to note that variation of 500 per cent has been observed between the yield from relatively " uniform " and comparable areas of natural pasture. This figure agrees almost exactly with observations that I have made on winter rainfall pastures in Southern Australia, so that our experiences in Australia may be of considerable value in your discussion on technique.

At this juncture I wish heartily to endorse Mr. M. V. Laurie's outlook on the problem of technique, but I am not quite as pessimistic perhaps insofar as I believe there is a way over the difficulty, but one way only.

I have designed and conducted many grazing trials in both natural and sown pastures in the past decade and have slowly overcome each obstacle until now the position is, to my mind, fairly straightforward. It is merely a matter of correct replication, and from this follows the extremely important sub-division of experimental areas into grazing units, i.e., fencing. The first observation I make is that any set of plots rotationally and sequentially grazed is for statistical purposes *one replication* only. Therefore it is essential to my mind that you subdivide your 40 acres into at least 5 blocks of 2 plots, the 5 replications of continuous grazing being 4 acres each, and the remaining 5 plots further subdivided into one acre sub-plots—the four sub-plots being grazed in a monthly rotation. I regard 5 replications as the absolute minimum number that can be used. The practical difficulties of fencing are not insurmountable, e.g., in two recent sheep grazing trial lay-outs I have employed (a) 2·75 miles of fencing for a nine-acre trial, and (b) approximately 4 miles of fencing on an 18 acre trial. Your fencing problem is much cheaper to solve, for you are handling cattle and you have the new electric fences at your disposal—on which £20 Australian goes a long way. Electric fences moreover are easily erected and dismantled.

The second objection to replication is that the size of flock or herd must be maintained at a certain level. We have very successfully used flocks of 4, 3, 2 and 1 sheep per flock, so that one cattle beast can be regarded as your minimum herd size. In South Africa they make very extensive use of 2 cattle per herd. For *statistical comparisons*, however, your herd unit is 10 with 5 replications of a 2-cattle herd.

This question of subdividing the experimental area into blocks is by far the most insistent question. The problem of sampling the plots is really subsidiary. It is far more important to *replicate the treatments* than it is to aim at great precision in sampling the individual plots.

On this basis I think the best solution I can put forward for your consideration is a hypothetical design. If I knew the carrying capacity of your grassland I could have been rather more precise—but I have assumed a carrying capacity of one cattle beast per acre per annum—which is probably too high. It merely means that more total area is called for in the experiment if my estimate is too high or that the unit herd size be reduced.

Hypothetical Design of Grazing Trial:

Objective: To compare the effect of two systems of grazing, namely, continuous and monthly rotational on the yield and botanical composition of a pasture.

Area required: 48 acres.

Lay-out: 6 randomized blocks of two treatments.

Treatments: (a) Continuous grazing.
(b) Rotational grazing (monthly) during growing season.

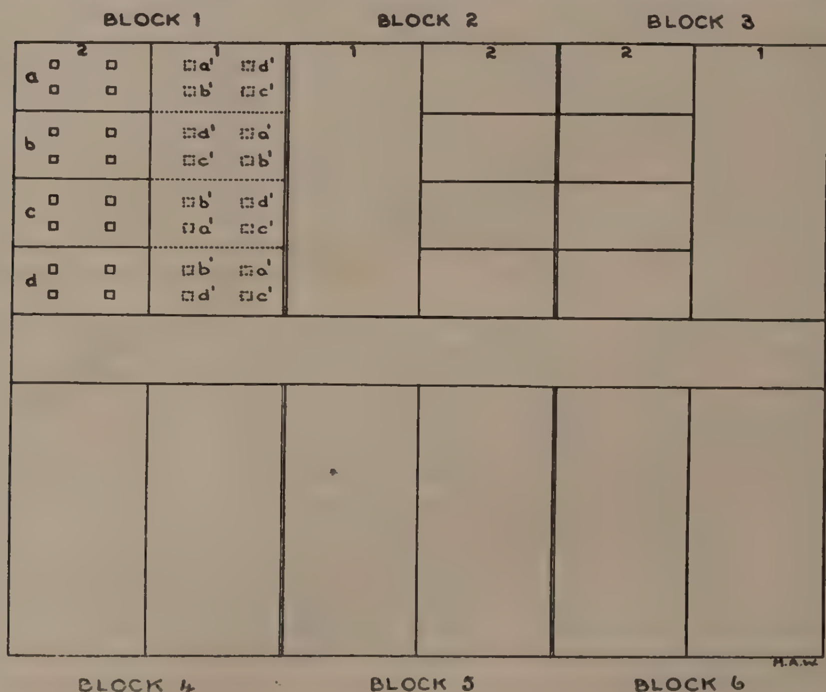
Plot size.: Treatment (a) = 4 acres.
Treatment (b) = 4 acres—subdivided into 4 sub-plots sequentially grazed, one week on, three weeks off.

Herd size: 4 cattle beasts per replicate which gives a total of 48 cattle on the experiment.
(N.B.—If your carrying capacity is 1 beast to 4 acres, the herd size will be 1 cattle beast).

Records: (a) Weekly liveweight increases might be considered possible.
(b) Yield of pasture.

On *each acre* irrespective of whether it is fenced or not 4 random quadrats each of 10 × 5 or 5 × 5 links to be harvested each 28 days, namely, at the conclusion of the grazing week for each plot.

Thus each *week* on the continuously grazed plots, one random quadrat *on each acre* of the four acres would be harvested—while on the four rotationally grazed sub-plots a corresponding 4 quadrats harvested on the plot last grazed. (See plan).



Block 1 only is given in detail.

Four sample groups, a, b, c and d, cut at end of 1st, 2nd, 3rd and 4th weeks.

Four sample groups, a^1, b^1, c^1 and d^1 cut at end of 1st, 2nd, 3rd and 4th weeks, each selected at random within its hypothetical acre.

Thus at the end of each monthly cycle there will be complete orthogonality of the yield data on both continuously and rotationally grazed treatments, and 16 samples will be available from each of six replications of two treatments—making

$6 \times 32 = 192$ samples per month. Such a number I have found quite easy to handle and to obtain therefrom the oven dry weights.

(c) *Botanical composition*—I have found that it is quite unnecessary to analyse the herbage from each cut. I have finalised my technique in this regard by taking one or two critical periods, e.g., flowering period of the major species + a typical vegetative stage—in your case perhaps 4 weeks after the monsoon break—and there to make very complete hand separations into any suitable categories. With us a common one is grasses, legumes and miscellaneous weeds, or if there are one or two important dominants we might split into :

Dominant grass A,

Annual grasses, Legumes, Miscellaneous.

Dominant grass B,

In rare cases a complete separation into some 20 groups is attempted. Estimations have been discarded as being quite unreliable except in very rare and simple cases.

For the hand separation a sample varying from 30 to 100 grams* dry weight (depending on the coarseness of the herbage to be handled) is taken and hand separated, and every attempt is made to separate the *green* material before it dries and becomes brittle. The sample after hand separation is either oven- or air-dried and the total weight of the separates added to the bulk weight of the original sample from which they were taken. Thus the only weighings required are the final weighings.

It will be noted that no attempt is made to estimate the quantity of pasture eaten by the grazing animal. Any attempt to do so under the conditions of the experiment as I see it will be quite fruitless and for the following reasons. The growth period is three months (or approximately so) and during this period the pasture must (a) provide the stock with food, (b) provide enough bulk to maintain the stock during the remainder of the year. This means that the average *rate of growth* of the pasture is at least four times the rate of consumption, very probably it is eight to ten times the rate of consumption. In practice I have found that to detect the quantities eaten by the grazing animal, the number of replications must be greatly increased ; the increase being a function of the intensity of grazing in relation to the total available pasture. In your case I cannot see that this can be attempted and I very much doubt whether it is, in fact, worth attempting.

A further comment : It is not necessary to have Blocks 1—6 contiguous from a statistical point of view. Blocks 1 and 2 might be in one spot, 3 and 4 might be 4 miles away while 5 and 6 could be 20 miles further still.

The plot shape and the block shape can be modified to fit the exigencies of the situation of the land. These points are especially useful to note in uneven country or where a very atypical intrusion exists.

It is essential that the enclosures for sampling be moved on to a fresh area each time a cut is made. Our experience shows that to make a "clearing" cut on natural pasture is entirely wrong—the cut pasture does not recover from the cut for weeks and often for months, and the rate of growth on the cut area is entirely different from that of the same pasture uncut. This difference is not of great practical import in the case of irrigated pastures or English pastures which are composed of rapidly growing and eminently "grazable" species, but on natural pastures commonly subject only to light picking a clearing cut gives an entirely erroneous measure of subsequent growth.

The objective aimed at is the estimate of the amount of food available to the grazing animal at all and any point within the season. The experimental design given will, I think, do this if modified to conform with your particular difficulties. If very high variability is anticipated then increase the number of blocks—it will be practically useless to increase the number of samples per plot.

*The limit adopted is that a sample should not take more than one hour to separate.

I trust this will give you some guidance. I am very aware of the difficulties confronting you because I have battled with them for many years and will probably do so for many more years.

Letter from Mr. E. Bruce Levy, Director, Grassland Division, Plant Research Bureau, Department of Scientific and Industrial Research, Box 16, *Palmerston North, New Zealand, to Dr. Burns. December* 5, 1939.

I have a letter dated the 24th July from the Imperial Bureau of Pastures and Forage Crops. The following comments are probably too late for the outlay of your present trial, but they may be of value to some future work.

The problem of measurement of yield under grazing and of determination of what feed is actually eaten by the grazing animal is difficult in practice.

Perhaps an account of some large scale trials that are under way in New Zealand may serve to throw some light on the method we deem best here.

Trial 1. Measurement under grazing conditions of total yearly yield of pasture and seasonal spread of production.

Area of field: 2.5 acres. Grazing by sheep alone.

Sixteen frames are used, each 10 ft. × 4.5 ft., constructed in the form of hurdles, hooked together at the ends when erected and stayed by iron spikes driven in at the side.

The frames are cut fortnightly but the cuts are not all made on the one day. Four frames are cut at 3-day intervals so as to give a better spread of production over any one fortnightly period. In this way it is possible to tell whether the growth of any one fortnightly period took place evenly throughout the fortnight or whether it was at the beginning or the end of the period.

The frames are moved to a fresh site after each cut and the arrangement for shifting is at random.

The new site is mown prior to the erection of the hurdles, but the fortnightly period does not commence until the enclosure has been mown a second time in order that the bottom growth that has been eaten by the sheep below mower height has made growth up to mower height. When this has taken place the area is again mown and closed up for the fortnightly period.

Trial 2. Determination of what feed is actually eaten by the grazing animal under a system of rotational grazing.

This trial is concerned with determination of state and stage of growth relative to feed that at certain times of the year and under certain physical conditions gives what is popularly termed "facial eczema" disease in New Zealand.

The area is 16 acres, grazed by sheep, and subdivided into four equal areas. The stock remain on each field for ten days and then rotate to the next field.

The hurdles accompany the sheep and are shifted each day. The size of the hurdle is as in trial 1. The material inside the hurdle is mown daily with a motor lawn mower and is disposed of as follows:—Part is fed to-stall fed sheep. Representative samples are used for chemical analyses and for determination of botanical composition by dissection.

The principle of shifting the hurdles daily is to approximate as nearly as possible to the feed actually being eaten by the grazing animals. Thus on the first day of the shift the sheep will be eating 20-day old feed. On the next day 21-day old feed plus some 1-day old, etc. On the last day of the shift the sheep are probably eating feed of 1-day old or less. The feed cut within the enclosures at the end of each grazing period will be 1-day old.

Trial 3. Determination of yield under grazing and fertilizer influence together with maintenance of thrift in the grazing animal.

Five different fertilizer treatments are under trial ; also five different sowings of pasture strains under a system of uniform manuring.

Area of trial—50 acres.

Sub-divided into 50 one-acre blocks, i.e., 5 one-acre blocks of each treatment. The treatments are staggered to occupy representative positions of the soil types and aspects of the block, i.e, they are not staggered at random but are deliberately arranged according to site and soil type.

Each set of five blocks has its own flock and this flock is rotated around the five blocks. Cattle are being used to keep the feed in a good sheep feed condition.

Appraisement of thrift in the flock is made by weighing ewes and lambs (in season) by fleece weight and fibre quality.

Determination of yield is made as in trials 1 and 2.

All the above trials are newly under way and before laying them down considerable thought was given to their layout.

I would point out that the New Zealand pastures are very high producing and there is virtually all the year round grazing. Thus smaller areas here would probably give an accuracy greater than they would with you under a more or less range type of management.

FACTORS AND FUNCTIONS IN COASTAL DUNES

[Reviewer : R. O. WHYTE]

The first of a new series from the Carnegie Institution of Washington has been published (1939) under the general title of "Adaptation and origin in the plant world," with reference on this occasion to factors and functions in coastal dunes. The authors are E. V. Martin and F. E. Clements. As this is a difficult work to present in an abridged form, a few quotations will merely be given to indicate the scope of the studies, the factors recorded in the analysis of the dune habitat, and concluding with a discussion of the criteria for xerophytes.

Scope of studies

" The dunes of oceans and lakes the world over have been favourite objects of ecological investigations for more than half a century, and their communities have contributed much to the concepts of dynamic ecology. A considerable share in this has been taken also by such relict dune complexes as the sandhills of the Great Plains and the Algodones of the Colorado Desert. It was to be expected that most of the attention would be paid to the general phenomena of succession, while the synthetic attack upon factors, functions and processes would await the development of adequate quantitative methods. As a consequence, studies of the adaptation of plants to dune conditions have been rare, apart from occasional records of the normal leaf structure. Measurements of physical factors have regularly been lacking and the experimental study of functions practically unknown.

" The initial installation of transplant gardens in nature for the experimental study of adaptation and origin was made at the Alpine Laboratory on Pikes Peak in 1901, and the gardens were increased in number and size in 1918 at Pikes Peak,

as well as by a new transect in the Sierra Nevada. In order to complete the series of climaxes and climates, a coastal garden was organized at Santa Barbara in 1925 and a dune garden nearby was installed in 1928. Since this date, instruments, phytometers and transplants have been maintained throughout the growing season at both places, and a large number of perennials have become permanently established to yield further results in adaptation. The primary study of factors and functions has now been concluded after ten years of experiment and the results are presented in the following pages. The complementary treatment of adaptation in a wide range of transplant species and native ecads is projected for the near future.

" Apart from the primary objective, the dune investigations have a bearing upon the question of alpine dwarfing at Pikes Peak. The two habitats possess in common a relatively high wind velocity, considerable fog and a dry sterile soil; they differ chiefly in the presence of a long winter and cold summer nights in the Alpine climax. As a consequence, both are characterized by a large number of dwarfed, prostrate or cushion forms, but with certain differences peculiar to each area. The habitat forms in both have been regarded as xerophytes, a view supported in general by the facts, but requiring much modification in detail, as is shown later (p. 50)."

Climatic factors

" The climatic factors measured were air temperature, relative humidity, wind velocity, radiation, rainfall, and the summation of these expressed as rate of evaporation. Instruments for measuring these factors were placed at heights of from one to two feet above the ground in open areas in order to avoid the influence of immediately adjacent vegetation."

* * * * *

Phytometer measurements were made with free and sealed phytometers. Results are given from observations on *Helianthus annuus* and *Lupinus chamissonis*.

The transpiration rates of native species were recorded, and the osmotic concentration of expressed sap was measured in the native species and the phytometers. The principal conclusions to be drawn from these measurements of transpiration rate are that a low rate per unit area is not necessarily characteristic of the perennials growing in the sand dunes, and that the structure of the leaf is not always an inidication of its transpiration rate.

The chapter on structural relations gives results of studies of leaf structure in phytometers, transplants and ecads, native species and desert species, and the root systems of certain native plants.

Points discussed in the final chapter on correlations are the role of physical factors, growth and life forms, leaf structure and holard, stomatal frequency, significance of salt control, the xerophytes of dune and desert, the nature of xerophytes, and criteria for xerophytes. The last section is quoted in full below.

There are many references, text figures, tables and plates of illustrations.

Criteria for xerophytes

" One of the chief contributions of dynamic ecology has been the demonstration that factor, function and form cannot be dealt with separately, but that each must be considered in the synthesis demanded by the complete working organism. In the early accounts of xerophytes, form was assigned too much importance, while at present the tendency is to over-emphasize function, especially transpiration. As a matter of fact, it appears probable that habitat may serve as the best criterion, when some sort of definition must be given. Probably at present there is not better distinction than the ability to endure critical drought seasonally or from time to time, a property

shared by desert succulents such as cacti, thorn shrubs like *Canotia* and *Holacantha* and such leafy xerophytes as *Larrea, Encelia* and *Prosopis*. In order to avoid the problem presented by three such dissimilar types, Maximov (1929) has excluded the succulents from his group of true xerophytes on the basis of their low transpiration. To American ecologists especially, no other form epitomizes xerophytic adaptation so strikingly, and its reduced transpiration is no small part of its compensatory equipment. Moreover, it seems to endure drought quite as much as it resists it, since the joints of *Opuntia* for example may shrink greatly and even collapse during excessive dryness.

" As a criterion, transpiration presents a further difficulty quite apart from a low rate in succulents and a high one in mesophytes generally. This relates not merely to the method to be employed in determining it, but also to the plant itself. Whole plants in containers, shoots as potometers, short-time weighing of leaves and loss of green weight usually yield different ratios and the discrepancy is often striking. Thus, on the basis of "momentaneous" transpiration, *Helianthus* bears a relation of 89 to 100 for *Franseria*, but on that of loss in green weight of shoots, the situation is reversed, namely, 230 : 100, which accords much better with their comparative success and survival in the dunes. The dilemma of the ecologist is well illustrated by the variable ranking of species obtained by Schratz, on the three separate bases, viz. per cent of water loss on fresh weight, on sap-content, and transpiration per unit area. In this order, the rankings of the seven species were as follows : *Ecelia*, 1,2,1 ; *Jatropha*, 2,1,6 ; *Boerhavia*, 3,6,3 ; *Cassia*, 4,5,2 ; *Larrea*, 5,4,4 ; *Prosopis*, 6,3,5 ; *Fouquieria*, 7,7,7. It is interesting, and perhaps significant, to find that the performance is so consistent at the two extremes, *Encelia* and *Fouquieria*.

" Even in the present stage of experimental ecology, it is possible to refine the criteria for xerophytes and thus provide a more secure foundation for further investigation. As the motive force in adaptation, all changes must be referred back to the habitat in quantitative terms, and hence the latter must be subjected to exhaustive analysis. No deserts are completely without rain and none is devoid of an occasional spring, or oasis. Flushes of winter or summer annuals are regular phenomena in the deserts of the South-west, and even in Death Valley sedges and rushes flourish in the margins of ponds. Moreover, it must be constantly kept in mind that it is the whole plant that must find compensation for a dry habitat or time and that root and shoot must be taken together as co-operators. When it becomes possible to express root efficiently in sums of absorbing surface as a ratio of shoot surface, much of the endurance of xerophytes will be explained. It is probable that too much emphasis has been put upon modification of leaf structure for reducing transpiration and too little upon reduced growth of shoot, reduction in number and size of leaves, and in the seasonal loss of transpiring parts. This suggests that more attention should be paid to quantitative and less to qualitative adjustments, and that the role of cuticle, hairs, stomatal numbers and mesophyll differences should be a matter of experiment rather than assumption.

" Further studies of the nature and response of xerophytes, as well as of other habitat-forms and life-forms, must be increasingly quantative and experimental, as well as adequately synthetic. In spite of the universal fondness for definitions and classifications, the experience of the past indicates that attempts to define and classify must be regarded as merely tentative and preliminary until the synthetic experimental attack upon factor, function and form becomes the recognized procedure. Classification in particular shows an all but irresistible tendency to become stereotyped in static terms, as the current practice with species and communities demonstrates. Habitat-forms have suffered somewhat less, partly because they have been much less studied and partly because they lend themselves much more readily to experiment and factor

correlation. Since they are concerned with the vegetative body, they offer the best avenue of approach to problems of adaptation and origin in nature, and hence to the dynamic analysis of species and communities on the basis of measurement and experiment rather than tradition."

THE FORAGE AND CONSERVATION VALUE OF LESPEDEZA

[Reviewer: R. O. WHYTE]

The name of Dr. A. J. Pieters will always be associated with the work he carried out for many years in the Bureau of Plant Industry at Washington in connexion with the introduction, improvement and promotion of cultivation of the annual and perennial species of *Lespedeza*.* A great deal of the information acquired over a long period in the Bureau and latterly in the Soil Conservation Service has now been published in the form of Circulars No. 534 and 536 of the U.S. Department of Agriculture (November, 1939), dealing with the value for forage and soil conservation of the perennial and annual species respectively.

The farmers in the Southern States of U.S.A. first became acquainted with the lespedezas through the important service rendered by the two annual species, Common and Korean. These are the only annual forms among the 125 known species. The genus is found only in eastern North America and in eastern Asia; about twenty perennial species are native to North America.

Circular 534 is chiefly concerned with *Lespedeza sericea*, an introduction from Japan with a habit of growth like that of alfalfa. It is not yet possible to delimit precisely the climatic and soil adaptations of this crop. Variations observed in winter resistance may be due to differences in heaving, or in ground cover, snow or debris. The species is affected by length of day. Although it will endure extreme drought when once established, it is in no sense a dryland plant. As far as present knowledge goes, *L. sericea* would appear to be a plant for the territory from perhaps a hundred miles north of the Ohio River to the Gulf of Mexico, and from the Atlantic Coast to central Kansas and Oklahoma. It is not a competitor of alfalfa, its place being on the sour eroded soils of low fertility level throughout the south-eastern quarter of the United States.

Circular 534 gives full details regarding cultivation (including the question of hard seed), diseases, weed competition, value of hay, chemical composition of hay, feeding trials, *sericea* meal, *sericea* for silage and grazing, seed production, and the place of the species in the soil conservation programme.

Good hay can be made from *sericea*, but it must be cut early; the number of cuts varies with location and fertility of soil. The question of tannin content of *sericea* hay is discussed in detail. A final conclusion on the value of *sericea* silage must await adequate feeding trials. Perhaps the most controversial subject in the entire problem of the utilization of *sericea* is its use for grazing. Both sides of the question are discussed.

Circular 534 closes with notes on the species and varieties of perennial lespedezas, a list of their chromosome numbers, and a bibliography of twenty-two references.

The annual lespedezas are without rivals for the special purpose of conserving the soil in the worn, eroded corn and other fields of the South and at the same time

*It is with sincere regret that we have to record the death of Dr. Pieters on April 25, 1940. A note on his career will be published in the September issue of *Herb. Rev.*—R.O.W.

yielding an income by providing fodder. They are at present widely used in the soil conservation programme and, with proper attention to management and utilization with other crops, will undoubtedly be even more widely used in the future. It is stressed that the annual lespedezas are not competitors of the clovers or alfalfa. Lespedezas are suited to soils of a lower fertility level than clovers, and it is on such soils that they are paramount. No other legume has a more important part over so wide a territory of U.S.A. in checking erosion and in gradually improving worn land with the least outlay of cash.

The two annual species of lespedeza are *L. striata* (Common, Kobe and Tennessee 76), and *L. stipulacea* (Korean, Harbin, and the early Korean U.S.D.A. 19604). *L. stipulacea* differs from *L. striata* in having a much broader leaflet and a broad stipule. The growth is larger and coarser, and except in thick stands the habit is prostrate.

Dr. Pieters discusses the geographical range and history of the various types. The annual lespedezas are hot-weather plants, and most of them will not bloom and seed under a long day. All are slow to begin growth in the spring; all continue to grow until frost except *L. stipulacea*, which stops growing with maturity of the seed. None of the annual forms can stand severe frosts. They are strongly drought resistant but make little if any growth during prolonged drought.

The annual lespedezas are primarily pasture plants, either in association with grasses, or, in the improved varieties, used as pure stands. The carrying capacity of a good stand is high. Lespedeza starts late and grows slowly at first, and is not therefore a plant for early grazing. It makes up for this, however, in midsummer when grass is poor. It is recommended as a constitutent of all permanent pastures in the South.

A great deal of lespedeza is seeded on fields included in a regular rotation, the legume being grazed for one or more years before being ploughed under. The Missouri Agricultural Experiment Station has taken advantage of the fact that the annual lespedezas are ideal summer-pasture plants to develop a pasture system based on *Poa pratensis* for spring, and Korean lespedeza for summer, supplemented by grain pasture during autumn and early spring.

Well-made annual lespedeza hay is of excellent quality, carrying 55 to 66 per cent of leaves by weight.

Korean lespedeza has been used with some success as a cover crop in apple and peach orchards. It does not deprive the trees of moisture in early spring, and shades and covers the ground during the summer, preventing erosion and adding organic matter and nitrogen to the soil. It also provides a mass of protective debris in winter.

The control or minimizing of erosion is carried out by two means, mechanical, such as terracing and contour cultivation, and vegetative. The latter is secured by strip cropping, the vegetative control of water-ways, or the retirement of certain fields to woodland or pasture. In all these except retirement to woodland, lespedeza plays a part. As noted above, it is also introduced into the rotation. It is also used to revegetate gullies, or to protect roadside banks.

Circular 536 ends with recommendations for the use of lespedeza in pastures. Wherever Bermuda grass (*Cynodon dactylon*) does well, lespedeza should be seeded with it as this will tend to minimize soil loss in winter. Seeding with better grasses on poor soils will lead to the crowding out of the grasses by competition. A winter annual grass that will reseed and give way to lespedeza for the summer will probably be more satisfactory. Such a combination is being successfully used in north-central Tennessee where *Bromus japonicus* makes good late-winter and early-spring grazing, reseeds and gives way to lespedeza.

The literature cited on annual lespedezas covers forty-three references.

PRAIRIE FARM REHABILITATION

[Reviewer: R. O. WHYTE]

Some reference has already been made in Bulletin 25 from this Bureau (pp. 178 and 189) to the functions of the Prairie Farm Rehabilitation Act. The Canadian Society of Technical Agriculturists has now devoted a special issue of their Review to a presentation of all aspects of the programme for permanent rehabilitation of the affected areas in Western Canada. This publication does not describe the situation, as the agricultural public in Canada for whom it is intended are already sufficiently aware of that; instead, it describes what is being done to correct the situation and outlines the policies under way to meet recurrent adverse climatic conditions in future years. The outlook for permanent rehabilitation is encouraging.

The following list of contents will give a good idea of the wide scope of this special issue:

* * * * * * *

S. E. Clarke and his collaborators describe the grazing surveys which have been made in Alberta and Saskatchewan in the years 1937 and 1938, and state how these apply to land utilization and community pasture management.

The large scale regrassing programme on abandoned lands and depleted pastures started in 1935 under the P.F.R.A. is now being developed along the following lines: regrassing of community pastures, reclaimed areas, regrassing experiments on special areas, regrassing demonstrations, and the establishment of seed production plots. Large areas of abandoned land and unproductive pasture have been reseeded and are now producing four or five times their former yield. *Agropyron cristatum* has proved its ability to live through dry periods, and to be of value in a long term rotation ley, adding fibre to the soil and thus controlling drifting. This latter fact will undoubtedly have a stabilizing effect on grain farming in the prairie region.

According to L. E. Kirk and T. M. Stevenson, " the facilities provided by Dominion Experimental Station in Manitoba, Saskatchewan and Alberta, and the Dominion Forage Crops Laboratory, co-operating with the University of Saskatchewan, made it possible to promote all phases of forage crop expansion in a well co-ordinated programme of work which has already more than justified the effort expended on this phase of the Prairie Farm Rehabilitation Programme.

" Interest in forage crops has increased markedly in recent years. The reasons for this are fairly obvious. Through introduction and breeding, new species and varieties which are better adapted to Western Canadian conditions have been made available. New methods of seeding have eliminated much of the risk resulting from poor 'catches.' The necessity of regrassing the lighter soil types in the drier areas and of restoring root fibre to the heavier soils to prevent drifting has become more and more obvious. The discovery that certain areas in the Prairie Provinces were highly adapted to the production of grass and legume seeds encouraged many farmers to specialize along this line. Finally, the unfavourable prospect for the sale of wheat in European markets has exerted a strong influence on the farms of Western Canada in the direction of greater diversification."

Grasses and legumes highly adapted to Western conditions were available for all sections of the Prairie Provinces when the P.F.R.A. work was begun. The grasses include slender wheatgrass, brome grass and crested wheatgrass; the legumes, alfalfa and sweet clover. A special section of the article is devoted to crested wheatgrass, its origin and adaptability, and the characteristics of the "Fairway" strain developed about fifteen years ago at the University of Saskatchewan. Nearly all the seed produced in Western Canada is of this variety.

Nothing has done more to promote grass culture in the drier sections of the West than certain discoveries made with regard to methods of seeding crested wheatgrass. These are vital considerations in securing good catches under prairie conditions, especially in dry seasons. Shallow seeding (depth of one-half inch) on firm soil done in autumn or very early spring is among the main essentials.

Under the policy of encouraging seed production, supplies of crested wheatgrass and alfalfa seed in particular have increased rapidly until in 1938 the estimated production of the farmer was 2,300,000 lb. and of the latter, 3,000,000 lb. in the three Prairie Provinces. In spite of this phenomenal increase in crested wheatgrass seed, abnormally high prices prevailed until the autumn of 1938, due largely to heavy exports to the United States.

Forage Crop Research

" Continuous support of research has been an integral part of the forage crop programme under P.F.R.A. Such investigational work has stressed plant breeding at the Division of Forage Plants, Central Experimental Farm, Ottawa, and its Branch Laboratory at the University of Saskatchewan. Various other investigations by the Dominion Forage Crops Laboratory at Saskatoon and Branch Experimental Stations in the three Prairie Provinces have contributed very materially to the success of the forage crop expansion programme. Several important original contributions to our knowledge also have already come out of this work.

" Among the most important of these should be listed the development of suitable techniques for establishing the small-seeded grasses and legumes under dryland conditions, especially crested wheatgrass.

" Real progress has been made in the field of plant breeding with grasses, legumes and other crops. Mention should be made in this connexion of Parkland brome grass, a new variety with dense, leafy foliage and an absence of the strongly spreading habit of growth, which is characteristic of this species. New selections of crested wheat-

grass have been obtained which show much promise. Strains of large-seeded, perennial wheatgrasses have been developed by crossing various species of wheat with *Agropyron* species which are closely related to couch grass. Among the legumes, alfalfa, sweet clover and soybeans have been worked with intensively. A self-tripping variety and promising pasture types of alfalfa are being tested and increased. New strains of sweet clover have been developed by crossing the Alpha variety with larger growing sorts, in order to increase plant size and vigour of growth. Extra early soybean varieties have resulted from hybridization, the earliest of which can be produced successfully in certain parts of Western Canada, notably in southern Manitoba.

" Many studies of a fundamental nature have been under way for some time. A partial list of these should include the following : breeding of sweet clover for low coumarin content : seed-setting in alfalfa and sweet clover, seed-coat permeability in sweet clover ; occurrence of selenium in western range plants ; relative value of different grasses for restoring soil fibre ; and value of including legumes with grass in hay and pasture mixtures."

THE ORIGINS OF AGRICULTURE IN THE MEDITERRANEAN REGION

[Reviewer : G. M. Roseveare]

Monsieur Auguste Chevalier, Member of the Institute, Professor, Natural History Museum, Paris, presents in *Rev. Bot. appl.* 19. 613-62, 1939, some notes not originally destined for publication, but regarded as merely a preface to a work on the origins of tropical agriculture which is in course of preparation. The author has utilized also some notes by the late Professor L. Joleaud on the domestication of animals in the Mediterranean region, and demonstrates the co-ordination between this domestication of animals and the origin of cultivated plants in that area.

He writes : " For a long time geographers and naturalists have given the name of ' Mediterranean Region ' to a vast natural territory more or less encircling the Mediterranean Sea, extending from western Asia to the Atlantic confines of Africa and Europe. It is characterized alike by its climate, its vegetation, and the flora from which the landscape derives so special a character, and also by the more or less analogous civilizations which have flourished in this country from earliest antiquity, at periods far in advance of history.

It is the Mediterranean Sea which has acted as a link between East and West, and we believe that it is by this route in particular and by the shores of the Mediterranean that, from the earliest days of the Neolithic age, hordes of invaders have advanced from Asia to the western confines of Europe. Again, it is by this route that, at the Graeco-Roman epoch, eastern culture and crafts have been able to permeate on the one hand as far as Mauretania, on the other to Gaul and Iberia, so that, from the earliest days, the men living in this vast area have been able to adopt a manner of life and practise an agriculture presenting very great analogies from one extremity of the Mediterranean coasts to the other." (pp. 614-5).

The Mediterranean climate is characterized by hot, dry summers of long duration, and by short and temperate winters, generally rainy, although—in accordance with geographical position and altitude—it is far from being uniform. It is the semi-arid zone, warm in winter, and comprising a large part of Provence, Liguria, Italy, Sicily, Attica, Crete and the islands of the Aegean, to which the name of Mediterranean

region in the strict sense is applied. The natural vegetation is of markedly xerophilous character, lacking in forest. " For thousands of years, the Mediterranean peoples waged ruthless war on the forests. The south of Europe is characterized by the absence of woodlands and the dissemination of some planted or protected trees in the midst of agricultural land. In certain places the pine has re-formed precarious and transitory forest, often becoming a prey of fires, and the true forest has little by little disappeared." (p. 651). "The Mediterranean region has seen the birth of the first civilizations ; from earliest antiquity it has been richly peopled by groups of progressive men. These peoples, by pastoral and cultural industry, transformed the primitive climatic plant associations, so that almost everywhere there were created degraded associations which persist ; the phenomena of degradation through flocks, herds and fires continue to prevail. The plant cover consists of ' garigues' [stone-heaths], ' maquis ' [sclerophyllous scrub], more or less incomplete forests of pines always liable to become fired, and numerous fallows and common grazings." (p. 616).

After giving an account of the first inhabitants of the region, and of the invasion of Neolithic man, the author describes in detail the domestication of various animals and, in close connexion therewith, the origin and first cultivation of plants for human and animal food.

" The early phase of agriculture was exclusively pastoral. There appears to be no doubt that everywhere, in Asia as well as in Europe or North Africa, transhumant pastoral industry has preceded a stable form of agriculture. When primitive man was in possession of herds and flocks of domestic animals, cattle, sheep, goats, he found it necessary to ensure grazing for them throughout the year. Now pastures, especially in the Mediterranean region, are seasonal ; in spring there is an abundance of rich herbage everywhere, but as soon as summer sets in the vegetation dries up and the animals cannot find any subsistence except in the valleys or on the mountains. Hence the necessity for transhumance, which was perhaps one of the principal causes of the great migrations.

Thus Neolithic man had to begin very early to cut trees and burn woods, to destroy the forests in order to make common grazings. All the tribe accompanied the flocks and herds in the course of their migrations, and lived both from the milk from the herds and from what they gathered, such as wild fruits and the seeds of grasses. In winter, acorns and other fruits must have been an important contribution to the nourishment of both men and animals. At the pastoral epoch there was not as yet any agricultural land, but only forests, savannahs, steppes, heaths and marshlands. Everywhere there was the primitive vegetation. This vegetation, however, was not long in retreating before the burning of the grasses and forests. When the grazings had become more extended, the settling of flocks began to develop in certain regions. The dearth of forage was supplemented by cutting the branches of certain trees, oaks, ash trees, elms, in order to furnish food for the animals in winter. Then there were fenced off here and there among the pastures, in the proximity of the huts and the water sources, small plots used for the sowing of the first cultures of native plants collected on the spot, or, more frequently, of plants imported from the East by the migrating populations. Thus little by little the exclusively pastoral system became supplanted by a system of mixed farming, agricultural and pastoral, in which, however, the flock or herd still held the principal place, probably up to the Middle Ages." (pp. 646-8).

" There is no doubt that one must go back to the Neolithic age to find the origin of the permanent agricultural village with fields tilled in rotation. In the North the cultivated territory is divided into three courses, devoted in turn to winter cereals, spring cereals, and fallow. In the South there are generally only two courses, the climate being unsuitable for the cultivation of spring cereals. These rotations fulfil

the double task of feeding men and cattle. The fields of each course, once divested of their harvest, become a vast open pasture for the flocks and herds of the whole village" (p. 649).

The following section on the origin of crop growing in the Mediterranean is of interest. "It is not only the cultivation of cereals and fruit trees that can be traced back to Neolithic days. A great number of the other food plants, notably the majority of our garden vegetables, were domesticated at a very early epoch, and certain of them, such as the lupin, the broad bean and the chickpea, were of even greater importance than they are at the present time. They were grown, like the cereals, as field crops.

The broad bean (*Faba vulgaris* [*Vicia Faba*]) was a legume very highly regarded in ancient Egypt, in Greece, and by the Romans. It has been found growing wild in North Africa, but it must have existed also in the East. In ancient times several varieties were already known, and, as in our days, beans were sown at the end of winter or at the beginning of spring. They were eaten in various ways, and were also given to ruminants as fodder.

The lupin was the next most important legume after the bean. The lupins normally under cultivation grow wild in all parts of the Mediterranean region. Thus they were domesticated in their native habitat. In Egypt *Lupinus termis* L. was grown. The species cultivated in Italy and in the south of Gaul was *L. albus*. Its culture has persisted in Corsica up to the last century, and we have also seen it grown in the Canary Islands. The lupin served as food for men and cattle ; sometimes it was used for making a coarse bread. As is known, it requires soils poor in calcium. According to Pliny, it was sown at Rome without tilling the soil and without any expenditure. In favourable soils (no doubt in fallow land) it was self-sown, and it was only necessary to harvest the ripe grain.

The chickpea (*Cicer arietinum* L.) had been imported from the East. It was cultivated in Greece as early as the days of Homer. It was very widely distributed in Italy at the time of the ancient Roman Empire and numerous varieties of it were known as early as the days of Pliny.

There were also cultivated in the Mediterranean region, from the earliest days, the lentil, emanating without doubt from Asia, the pea, of which wild races exist in the south of Europe and in Asia, and *Lathyrus sativus* L., cultivated to-day as a fodder crop and formerly eaten by the poorer classes.

The 'phasiole' of the ancients was not the haricot bean or *Phaseolus vulgaris*, which was not imported until after the discovery of America, it was the *Dolichos* of the Arabs, come probably from Arabia and introduced into Greece and Italy from ancient Egypt. At all events it still grows wild in the south of the Sahara, and the races cultivated by the natives in West and Central Africa emanate from the wild Sahara forms.

The turnips (*Brassica rapa* and *B. napus*) were also of very great importance in the agriculture of the primitive Mediterranean peoples. These plants with tuberous roots took the place now occupied by the potato, a plant then unknown in Europe. Pliny speaks of the turnip as the most important culture of transpadane Italy, after that of the vine and wheat. It even took precedence of the lupin. Turnips were sown in the fields in autumn. They were harvested throughout the winter, and might be kept in barns or even left in the ground from one year to the other. They were eaten cooked, often after they had been coloured, and were a great resource in times of famine. They were also fed to the farm animals. Three varieties existed in Italy ; one large, another rounded, the third—said to be wild—had an elongated root and resembled the Raifort. Some turnips weighed as much as 40 lb. It has been asked what was the turnip cultivated in the time of Pliny. There is no doubt that

it was the plant named by botanists *Brassica napus* L. var. *napobrassica* Peterm., which we call to-day the rutabaga, of which the wild type, related to colza and the navette (oleaginous plants grown to-day especially in India), is found in Russia and Transylvania, where the plant was first cultivated and whence it was brought into the Mediterranean basin in very early days by the Aryans. Since Neolithic times it has become distributed in Central Europe. Pliny cites also as plants cultivated in the fields the turnips which were sown in the spring or in the autumn. The turnips of Amiterne were renowned. These plants were without doubt analogous to *Brassica rapa* L. They emanate from a wild plant, *Brassica rapa* L. var. *silvestris* (Lamk.) Purchas et Ley, which is still found wild or semi-wild in the Mediterranean countries, and even in Switzerland and the north-west of Europe in the maritime sands. The plant must have been domesticated very early in these countries. It is known that the Celts also were great eaters of turnips, and in many of our provinces there are still cultivated by the peasants local varieties of undoubtedly very early origin" (pp. 642-4).

HERBAGE AND FORAGE PLANTS IN GREECE

[Reviewer: G. M. ROSEVEARE]

An account of the breeding of herbage and forage plants in Greece, in progress since 1933, is given by D. A. Panos in *Züchter*. 11. 341-6. 1939.

With a few unimportant exceptions, the cropping systems employed in Greece have remained almost unaltered for centuries, and consist either of the old three-course system with fallow or of the most recent development of this system, namely, cereal or wheat monoculture with fallow. The disadvantages of cropping of this nature are well known, namely, insufficient tillage and the consequent reduction of the soil's capacity for water retention—of especial importance in the hot climate of Greece. Most serious is the impossibility of maintaining sufficient stock. The employment of synthetic manures for the restoration of fertility is unprofitable in the case of the humus-deficient soils of Greece. Comparison is made with the three-course and fallow system customary in Germany in the nineteenth century, the elimination of fallowing in that country through the introduction of red clover and the gradual transition to systematic cropping, increased stock-raising and improved soil fertility. The object of work in Greece is to bring about a similar transition, wherein it is considered likely that *Trifolium incarnatum* will play the part played by *T. pratense* in Germany. The necessity for such development is illustrated by statistics showing, among other things, that the live stock of Greece consists 93 per cent of small animals and only 7 per cent of cattle, and that the area sown to cereals is larger than that of any other European country except Rumania, while the yield of cereals is the lowest in Europe. Moreover, the cost of importing necessary articles of consumption occasions for Greece an annual deficit of approximately a billion drachmas.

While experiments and trials are conducted in different parts of the country, the work is mainly carried out at Larissa, where climatic and edaphic conditions are as follows.

Annual mean temperature for the years 1900 to 1929 amounted to 16.1°C., namely, in the autumn 16.8°C., in the winter 6.6°C., in the spring 14.9°C. and in the

summer 26.1°C. The absolute maximum for the years 1894 to 1929 was 14.5°C., the absolute minimum—13°C. The mean precipitation for the years 1894 to 1929 was 518.4 mm., distributed as follows: in the autumn, 162.8 mm. or 31.4 per cent; in the winter, 152.1 mm. or 29 per cent; in the spring 127.4 mm. or 24.6 per cent; and in the summer 76.1 mm. or 14.7 per cent. The distribution of precipitation is extraordinarily unequal. The quantity of water at the disposal of the plants during the growth period is very small; during the winter and autumn, on the other hand, excessively heavy and sudden rainfall occurs.

Duration of sunshine on an average of the years 1900 to 1929 amounted to 2,520 hours, distributed as follows: autumn, 535; winter, 371; spring, 615; and summer, 999 hours respectively. For the production of protein and fat plants, the Grecian climate, on account of the hot summer and on account of a mean daily duration of sunshine of eleven hours, is very suitable. The favourable effect of the climate is seen particularly clearly in the case of the irrigated fields. Mean humidity for the years 1900 to 1929 amounted to 69.2, that is to say, in the autumn 72.1, in the winter 80.8, in the spring 69 and in the summer 54.9. Average clouding for the years 1900 to 1929 was 4.5, namely, in the autumn, 4.8, in the winter 5.8, in the spring 4.9, and in the summer 2.4. The soil in which the principal experiments are carried out is a typical clay soil, with 63 to 72 per cent fine earth and 28 to 37 per cent sand. Tillage and plant development are both made difficult by a high degree of cohesion and high water capacity and a great capacity for retention; soil reaction is neutral (pH 6.7 to 7.14). Humus content, namely, 1 per cent, is too low, as is likewise calcium content. Calcium is completely leached out in the uppermost layer of 0.15 m. and is concentrated in the lower strata of 0.80 to 1.20 m.

The primary object of work at Larissa has been to obtain varieties of annuals sufficiently productive and reliable in yield to be suitable for use in place of fallow. Collections were made of 386 different indigenous varieties of peas, horse beans, *Lathyrus*, vetch, lentils, *Vicia articulata* Hornem., beans, *Cicer*, and soybeans, and of 883 varieties of herbage and forage plants from countries in all parts of the world where physical conditions resemble those of Greece. For the testing of these varieties 51,902 plots were available at Larissa, and in addition 25,000 plots distributed over 507 experiments in different parts of Greece. From this material over 30,000 strains were selected during the years 1933-38. Of these 878, or 3 per cent, remain at the present day and are undergoing further trial.

In addition to selection, hybridization has also been carried out, the material including *Pisum*, *Lathyrus*, *Vicia Faba*, *V. sativa*, *Soja hispida* and *Phaseolus vulgaris*. Over 11,000 crosses have been made, of which 11.5 per cent exhibited seed-setting.

The second object of work at Larissa was the discovery of perennials suitable for the laying down of meadows and pastures. For this purpose 670 different indigenous varieties were collected, emanating from most parts of the country. From these it was possible to select types which, when they have been bred further, will be equal in value to the best foreign varieties. There were also obtained from abroad for comparative purposes 519 varieties of 157 different species. For the growing of these 7,582 plots were available.

The principal herbage and forage plants of which different varieties have been collected and tested are the following: *Avena*, *Agropyron*, *Andropogon*, *Alopecurus*, *Anthyllis*, *Bromus*, *Dactylis*, *Sorghum vulgare*, *Festuca*, *Hedysarum*, *Holcus*, *Lotus*, *Lespedeza*, *Lolium*, *Medicago*, *Melilotus*, *Onobrychis*, *Ornithopus*, *Phalaris*, *Panicum*, *Poterium sanguisorba*, *Paspalum dilatatum*, *Phleum*, *Poa*, *Trifolium alexandrinum*, *Trifolium incarnatum*, *Trifolium subterraneum*, *Trifolium pratense*, *Trifolium hybridum* and *Trifolium repens*. Of *Medicago sativa*, as the principal forage plant, eighty-four different varieties have been tested.

In addition to the above-named plants, reference should be made to *Helianthus tuberosus*, which was introduced into Greece in 1933 by way of experiment, tested in the most important parts of the country, and then submitted to breeding work. Its cultivation has been found particularly valuable in the hill regions. In the fertile lands of Macedonia and Ipiros maximum yields of thirty to fifty thousand kg. per hectare have been obtained, under ordinary circumstances the average yield is approximately 15,000 kg. per hectare. A rapid extension of this culture is anticipated.

Results achieved up to the present are summarized as follows.

In *Pisum*, *Lathyrus*, *Vicia articulata* Hornem., vetch, lentils and horse beans, varieties have been selected which, grown as field crops, are capable of giving an annual yield approximately double that of the indigenous varieties hitherto grown. For example, a field pea has been selected which is both winterhardy and tolerant of short periods of flooding, and which, sown in winter, gives even in the coldest parts of Greece a yield at least as reliable and high as that of a winter forage cereal. Its mean yield has been over 1,000 kg. per hectare, and in the suitable districts of the north-east and north-west it is expected to furnish a reliable basis for the production of protein. An indigenous species of *Lathyrus*, *L. cicera*, tested in 124 variety trials in different parts of Greece, gave a mean yield of 1,250 kg. per hectare in the years 1934 to 1938. This species is very resistant to drought, cold, and flooding ; it exhibits a high degree of adaptation to the climate and can be grown in difficult soils. Some of the selected varieties of lentils and *Vicia Ervilia* are very resistant to cold : they are more reliable than the varieties previously employed and give on the same land a yield 30 to 50 per cent greater than that of the old varieties. The cultivation of these selected varieties may well take the place of fallowing.

It has further been found that crimson clover (*Trifolium incarnatum*) can be grown successfully in Thessaly and give a hay yield of three to six thousand kg. per hectare. The area used to-day as fallow could, if sown to crimson clover, furnish over 50,000 hectares of forage crop.

The systematic breeding of soybeans has been initiated. Three hundred different varieties have been tested, those most suitable for conditions in Greece being selected. Under normal circumstances yields equal to the mean yield of forage cereals, that is to say, over 860 kg. per hectare, can be obtained, although some varieties give even higher yields.

Varieties of perennial herbage plants have been selected, capable of furnishing hay crops of three to seven thousand kg. per hectare and of supplying grazing after the hay cuts have been taken. The following table shows the mean yield obtained from the principal perennials in two to five years' cultivation at Larissa.

No.	Species.	Duration of trial. Years.	Mean yield kg. per hectare.
M –1043	*Phalaris tuberosa*	3	4,485
M—1039	*Avena elatior*	3	2,490
M 446	*Eragrostis curvula*	3	3,920
M 199	*Hedysarum coronarium*	5	2,430
M –160	*Lotus corniculatus*	5	3,470
M –405	*Medicago sativa*	4	6,660
M—1109	*Melilotus albus*	2	3,460
M –1099	*Melilotus officinalis*	2	4,650
M—420	*Onobrychis sativa*	5	3,340
M –499	*Onobrychis persica*	2	6,165
M—1045	*Paspalum dilatatum*	3	3,385
M—455	*Poterium sanguisorba*	5	5,730

VELD AND PERMANENT PASTURE IN PRETORIA DISTRICT

[Reviewer : M. Hall]

Science Bulletin No. 203 of the Union of South Africa Department of Agriculture and Forestry is concerned with investigations into the productivity and management of the natural veld and permanent pasture on a certain soil type in the Pretoria district. The bulletin forms memoir No. 1 of the Veld Management and Pasture Research Series and is written by J. W. Rowland, Pretoria, 1939, pp. 197.

The climate at Pretoria is one of warm rainy summers and cool dry winters. Altitude is about 4,500 ft., and the soil consists of loose reddish sand derived from quartzite, and there are shale outcrops. Vegetation consists of open mixed grass sward with occasional low bushes, and the common practice is to graze through the summer on a free range basis, to burn a portion of the grazing each winter, and to rely on trekking or artificial feeding, maize stalks and open veld grazing for winter rations. Owing to difficulties of trekking there is a tendency to organize the farm on a 12-month basis, but the type of livestock which survives under present conditions is poor.

In spring *Elyonurus argenteus* is palatable, together with remains of *Themeda triandra*, *Brachiaria serrata*, *Diplachne*, etc., which sprout later. In summer the grass grows considerably more quickly than stock can consume it and the herbage flowers and sets seed. Continuous stocking through the summer, especially after light grazing or complete resting in spring, favours the spread of grasses which are of no use in autumn. Thus in winter and early spring (a period of six months or more) the veld fails to provide even a maintenance ration for dry stock. The soil does not produce good arable land forage and the difficulties of providing feed for milk cows and fattening oxen in winter are great.

The trials under review are designed to explore methods for organizing a plan of grazing throughout the year, and the following lines of experimentation have been followed :

(1) *Productivity of veld.* Determination is made of actual weights of dry matter, protein and phosphate produced from an acre of veld each year, effect of different systems of defoliation, cultivation and fertilizer treatments.

(2) *Veld utilization.* This involves trials of various systems of management to investigate (a) achievement of continuity of feedstuff flow from veld to animal ; (b) proportion of herbage produced which can be safely grazed without damage to pasture, and (c) herbage quality as distinct from quantity and its suitability for stock at different times of the year.

Details are supplied of experiments made in different seasons from summer 1935-6 to winter 1938. The data obtained have led to the formulation of a grazing policy, but application of the findings to farming practice has still to be tested.

It has been ascertained that the capacity of the veld for improvement in winter conditions by means of fertilizers is much greater than its capacity for improvement in summer conditions by fertilizers. Also the pasture is capable of supplying, per 24 sq. yards each year, over 4,000 grm. dry matter, over 300 grm. protein and over 100 grm. P_2O_5. Management practices described provide means by which this production may be conserved. Seasonal fluctuations in protein and phosphate percentages of air-dry herbage are given in graphical form in regard to unfertilized veld, fertilized veld and unfertilized *Digitaria Pentzii*. The great scope for improvement of winter supplies by management, the need for hay grasses and artificial pastures for spring and autumn grazing to supplement the veld, and the importance of haymaking for the provision of year-long rations for stock are items stressed.

Comparisons are made (by means of charts and tabulations) of the quantity of herbage, protein and phosphate that can be supplied by veld, fertilized veld and artificial pasture under different grazing systems.

The investigation has shown that there is a sharp contrast between growth-period management and winter management. In the former, sward maintenance is of primary importance and in the latter the main consideration is a flow of feed of adequate quality.

A special area may be reserved for spring grazing (5 acres are required for two oxen), but better results are obtained by mowing 5 acres of veld and feeding the hay during winter and spring. By the use of fertilized veld hay, 3 acres mown are sufficient for two steers. Artificial pastures of *Digitaria* "*Malmaniesoog*," give a good spring ration if used for this purpose alone. In regard to summer grazing, five possible methods are discussed, but no definite recommendations can be made. Three possible methods for autumn grazing are considered. There is little information gathered so far, however, except that autumn conditions can be improved without much difficulty or cost. Various possible ways of providing winter rations from veld and pasture are described and discussed in the light of experimental data. The work carried out by Dr. Pole Evans and his associates at Rietondale shows that using artificial pasture as a hay crop and the aftermath as winter grazing gives the greatest promise.

The year-long systems discussed are :—(1) veld alone, not supplemented by artificial pastures or arable land ; (2) as 1, but the hay camp is fertilized ; (3) as 1, but no hay made ; (4) veld used for summer, autumn and winter, and artificial pasture used for spring grazing ; and (5) veld used for summer and autumn grazing, and artificial pasture used for winter and spring. Further work is necessary before the data can be profitably discussed, but it is already evident that enlightened management will effect considerable improvement.

PHASIC DEVELOPMENT OF PLANTS (5)

A review recently prepared by the staff of the Imperial Bureau of Pastures and Forage Crops, and published under the authorship of R. O. Whyte, *Biol. Rev.* 14. 51-87. 1939, is being summarized and supplemented in serial form in successive issues of *Herbage Reviews*. The first discussions appeared in March, June, September, and December issues of 1939, pp. 27-32, 94-9, 181-9 and 265-74, respectively. This is the fifth and final section, and contains the bibliography. Arrangements may be made for the reproduction of the five parts of the series in a suitable form in the near future.

Topophysis

In the preceding parts of this review we have repeatedly referred to the well-established fact that different parts of a plant are not equivalent in their state of development. This phenomenon, based upon a differentiation of cells and tissues along the main stem, is well known and has been utilized to some extent in agricultural and horticultural practice ; Molisch (1922) coined the term "topophysis" to describe it. Conspicuous differences in the behaviour of cuttings have been pointed out ; for instance, in experiments with *Circaea* (Dostal, 1911), the axillary buds from the upper portions

of the plants formed flower-bearing shoots, whereas those from the lower portions developed into vegetative shoots. This differentiation of tissues along the stem was related by one group of physiologists (Dostal, 1911, being one of the earliest) to all the complex correlations between different parts of a plant, and a balance of nutrients (particularly carbohydrates) within them, and by another group of physiologists (Snow, 1925, 1929 ; Vovčaneckiĭ, 1930, etc.) to the regulating action of hormonal substances, elaborated there as a result of the vital functions of individual plant organs. While refraining from any analysis of these concepts we shall indicate only that, in the light of what has been said in the preceding parts of this review, both of these hypothesis would appear to be incomplete ; the leading internal cause cannot be attributable to these factors separately, no matter how important they may be.

A different interpretation was suggested by Lysenko, with reference to his own investigations and those of his associates (pp. 72-3 and 76-7). Lysenko connected this differentiation with the conception that phasic readjustments arise as a result of the reaction of the plant to the environment only in meristematic cells, are retained there and transmitted thence only through cell division ; further advance is possible only in daughter cells. Consequently, with the growth and development of a plant, the higher the tissues are situated the more advanced they are in development. The axillary buds acquire the developmental quality of the mother tissues, retain and promote it, if and when the environmental conditions favour this.

Vertical Differentiation of Tissues

Therefore, the division of a plant into fruit-bearing and vegetative portions (for instance, those above and below the first sympodial shoot) does not sufficiently discriminate the latter ; some of the vegetative shoots may be at various degrees of completing the thermo-phase, some others may be at more advanced phases. Their response to environmental conditions will differ accordingly. Consequently, when cultivated under similar conditions they will flower, but at different times, some earlier, some later than the others, while some may fail to flower altogether. This kind of "topophysis" has been observed, for instance, by Eremeev (1939), who conducted a series of special investigations with tobacco.

In one of these experiments, the plants from the first three lower axillary buds had not formed buds, while those from the 10th, 11th and 12th axillary buds formed buds, and those from 15th to 20th were at various phases of flowering and fruit-formation. In another experiment, the axillary buds were grafted on the stem in the reverse order of their original situation, that is, the lower axillary buds above, the upper axillary buds below. Despite this, the shoot from the 19th axillary bud grafted on the lower portion flowered, while the shoot from the 4th bud grafted slightly above the former remained in a vegetative state. Therefore, there was not only a strict differentiation of shoots in respect of their readiness to flower, but also a tendency for them to retain this differentiation.

The differentiation of tissues along the stem as a result of the localization of the developmental readjustments of the plant, and the entire complex of relations existing between different parts and the tip of the main stem within a plant remain one of the more obscure fields of physiological research, despite a relatively large number of investigations establishing them. No review of this subject is intended here, the object being merely to draw attention to a new interpretation based upon the principles of the phasic development theory, which not so much replaced the two former hypotheses, as united them and "regulated" the significance of their leading factors.

The further elaboration of differentiation of tissues along the stem and correlations between lateral shoots and the main stem (the existence of which can hardly be doubted—for instance, the effect of nipping of the tips on development of lateral shoots) are of great importance not only in practice, where application is obvious, but also with regard to some physiological concepts ; in particular, it is only in terms of this differentiation that one can attempt to answer some of the questions raised by Hamner (1938) ; namely, a plant " may produce one blossom cluster, or a hundred, or a hundred thousand clusters. In any of these cases the tree may be considered as being in flower ".

Reversibility

" Lysenko himself has not investigated the physiological ' cause ' of reproduction " and reversibility, but the circumstantial evidence available (p. 72, 77 and elsewhere) led him to form a conception as to the irreversibility of the physico-chemical readjustments of the protoplasm determining the direction and rapidity of subsequent differentiation of tissues and, eventually, reproduction ; that is, the phasic readjustments are irreversible. They may be arrested by external and internal factors, but they cannot regress ; this, of course, does not preclude a continuation of growth, as growth cannot and must not be looked upon as being in " contra-distinction " to development. Consequently, the apical tissues of vernalized plants do not lose the properties acquired during vernalization of the thermo-phase, if grown under conditions preventing the onset and development of the subsequent phase. Furthermore, under conditions excluding the destruction of apical tissues, vernalized seed can be stored after drying without any loss of the properties acquired during vernalization (p. 72 ; and of recent reports, Sen, 1940).

In this respect, the experiments reported by Zarubaĭlo (1938) on the vernalization of unripe seeds without germination are particularly convincing ; seeds after such a vernalization can be ripened at high temperatures and stored through the winter until sowing in spring, without any damage to the properties acquired during vernalization. Moreover, the evidence quoted in the review (p. 65, 72 and elsewhere) in support of the possible vernalization of the thermo-phase and light-sensitive phases by instalments also necessarily assumes the irreversibility of acquired properties as well as the accumulative nature of these properties.

This somewhat uncompromising statement of Lysenko and his associates has been challenged repeatedly ; for instance, no less uncompromisingly by Loehwing (1939), who considers " that the rigidity of Lysenko's concept as to irreversibility in the light phase may . . . . undergo modification as already has the previous belief in irreversibility of the vernalization phase."

Despite the apparent simplicity of the issue, there is a gross misunderstanding regarding the diagnosis of reversibility, as no delay or failure in development nor any manifestation of growth during that period necessarily indicates the reversibility of the properties previously acquired in the apical tissues. On a careful examination of many cases of alleged reversibility (p. 73) the concept of reversibility was defined in the review as follows. " Reversibility assumes that a tissue has the faculty to proceed in two diametrically opposite directions as affected by environmental factors ", namely, " the progressive changes maturing the tissue and the regressive changes rejuvenating the same tissue ". Moreover, a discrimination was made between " rejuvenation of the plant as a whole ", for instance, cases of secondary flowering, and reversibility of tissues, the former having " nothing in common with true reversibility ". While the former has been reported repeatedly since Klebs' experiments, the latter " has not been proved experimentally ", a conclusion which may indicate anything but the alleged " rigidity " of the concept.

Ljubimenko (1933), one of the advocates of reversibility, was not after all as uncompromising as some of his followers ; he even advanced a hypothesis according to which changes occurring in cells during development of a phase are reversible until, as a result of an accumulation of these changes, they acquire a stability, that is, they become irreversible. He quoted no evidence in support of this hypothesis, and all the cases of reversibility claimed by him are traced in the review (p. 73) to " rejuvenation of the plant as a whole " which " could be described as enlargement of the tip or flowering of auxiliary stems, i.e., one of the less advanced auxiliary buds having resumed development as the environment was changed ", while development of the apical tissues of the main stem was suspended until the environment was appropriately changed and the growth alone continued ; there was no evidence of regressive changes in the quality acquired previously by the apical tissues.

Another hypothesis of reversibility was suggested by Gregory and Purvis (1938a). According to this, a " precursor " A is converted in an embryo of winter rye through autocatalysis at low temperatures into a substance B ; the latter, as affected by environmental conditions, could either produce a " leaf-promoting " substance E, or could in a short day produce a " flower-initiating " substance C, which in turn could in a long-day produce a "spikelet" maturation substance D. In this hypothetical scheme, which is reproduced below, the system $C \rightleftarrows B$ is claimed to be reversible. In support of this hypothesis, these authors refer to their experiments with rye in which, as they claim, devernalization (1938b) was shown, and of which more will be said below.

$$\begin{array}{ccccccc} & & E & & & & \\ & & \uparrow & & & & \\ A & \longrightarrow & B & \rightleftarrows & C & \longrightarrow & D. \end{array}$$

No other evidence in support of this hypothesis can be found in the relevant literature, except perhaps Efeĭkin's investigation (1939) discussed below.

Devernalization due to the Vernalization Period

The claims of reversibility due to over-vernalization can be dismissed without examination, as their incompetence (p. 73) was experimentally confirmed by Timofeeva (1934) and others, including Vasiljev (1939b), and is, in fact, evident from what has been said of vernalization in the preceding parts of this review.

It will not be amiss in this connexion to note, as a general guide, the duration of possible vernalization of seeds as affected by the growth rate (consequently, exhaustion of reserve nutrients in the seed) controlled by temperature and moisture of seeds during vernalization. At the same temperature, the duration of possible vernalization is determined by the moisture of seed under vernalization : the higher the moisture the shorter is the duration of possible vernalization. At the same initial moisture, the duration of possible vernalization is determined by the temperature of vernalization : the higher the temperature the shorter is the duration of possible vernalization. With the same growth rate (consumption of reserve nutrients), the duration of possible vernalization is the shorter the smaller are the seeds. Thus the concept as to " size " of seed is only relative, depending on the rate of growth inherent to the seed under particular conditions of vernalization.

Devernalization and the Thermoperiod

No more convincing is the claimed " devernalization " (Gregory and Purvis, 1936c, 1938b) described on p. 56, and yet quoted by Loehwing (1939) in support of

reversibility. In one of the experiments with winter rye, the seeds, while at low (vernalizing) temperatures, had access to the normal air, and while at high (devernalizing) temperatures they were in nitrogen ; thus these experimental series can hardly be regarded as comparable. The same may be said of the series in the experiment with vernalization of winter rye seed at low temperatures alternatively in the air and in nitrogen for twelve weeks and in the air for six weeks, on the basis of which it was claimed that " anaerobic conditions . . . ., as such, do not lead to a reversal of the vernalizing process ".

While discussing these experiments it is pointed out (p.59) that heading of plants after vernalization at alternative temperatures may be delayed or fail altogether, even though the daily period of " devernalizing " temperatures does not exceed a certain critical length ; this, however, will be due not to any " devernalization " but to under-vernalization, as vernalization will be suspended while seeds are exposed to " devernalizing " temperatures. If, however, duration of vernalization is sufficiently prolonged (for example, doubled as in the experiments under discussion) no " reversal of the vernalizing processes " will be in evidence merely because the seeds will be fully vernalized. The reviewer furthermore arrived at the concept of a critical thermoperiod for cases when the plants are grown at alternative temperatures, as actually happens during the spring season, which received further confirmation in Tetjurev's experiments (1939). Wheat and rye seeds were vernalized for 2, 4, 6, 8, etc., hours daily during 40 days (wheat) and 20 to 25 days (rye). Unfortunately, the duration of vernalization remained unchanged for all variants and the author was thus unable to detect the precise length of the critical thermoperiod, although the latter was evident. The question as to the critical thermoperiod should indeed receive closer attention, as it is of immediate significance in practice and science, particularly in the vernalization of plantules.

Devernalization at Subsequent High Temperatures

At a glance Efeĭkin's experiment (1939) with winter wheat, Durable, would appear to be more convincing. In this experiment, six-day treatment in " an electrically illuminated chamber " at 27 to 33°C. seemed to devernalize previously vernalized seeds (brought in immediately after vernalization, May 5 to 11) and part of the vernalized seedlings (brought in at development of second and third leaves, May 13 to 19), the plants failing to head and differing in no respect (morphology of apical cone and number of leaves) from the unvernalized control. The experimental plants before (except the first series) and after high-temperature treatment, as well as vernalized and unvernalized controls, were grown " on the window-sill, where the temperature varied from 13 to 17°C. until the end of May " and " then the temperature grew warmer in the room as it did outside ". Under these conditions the vernalized control headed on June 29 to July 14 ; part of the plants of the second series also headed, but on July 2. Therefore, vernalized seeds and some of the vernalized seedlings were, so to speak, devernalized, that is, they lost the properties acquired during 50-day vernalization at 0 to 2°C.

On a closer study, however, such negligence regarding the temperatures " on the window-sill " (within the range of vernalization in the beginning of the experiment and later outside it) and the absence of any indication as to the physiological state of the apical cones in the plants failing to head make it necessary to refrain from passing any judgment on these somewhat unexpected results and claims. After all, this apparent devernalization may be fully explained, if we assume that after the vernalization of seed (where there is always a certain amount of uncertainty) the thermo-phase could remain incomplete to a varying degree. A prolonged period of heading of the vernalized control and the difference in the behaviour of plants in the

second series, in fact, make such a supposition quite plausible. Biochemical study of the apical cones in seeds and plants, which is indispensable in this kind of study, would indeed remove all doubts. The experiment is not sufficiently detailed; it raises questions, but fails to answer them.

Reversibility and Grafting

Referring to his numerous grafting experiments in which " photoperiodically " different components were used, and particularly to his special investigation based upon similar principles, Moškov (1939c) concluded that the changes or formations induced in leaves by vernalizing photoperiods are irreversible. Undoubtedly, the grafting experiments of Moškov and others (cf. Cholodny, *Herb. Rev.* 7. 223-47. 1939), provided some grounds for assuming the irreversibility of photoperiodical induction. This was also shown in the experiments of Meljnik (p. 65 and 72) and Biddulph (p. 72). Nevertheless, one cannot fail to admit that the evidence thus procured in support of reversibility is more or less circumstantial, directing the thought rather than solving the problem.

More convincing perhaps would seem to be the experiments of Eremeev (1939); in the third series, grafting of lateral shoots in the reverse order to their original situation, that is, upper shoots below, lower shoots above, did not affect the order of their blooming established previously, that is, they retained the quality acquired during development on and off the mother stem.

On the other hand, however, some grafting requirements seem to convey an idea of possible reversibility, for instance, one of Čailahjan's experiments on the alternation of long and short photoperiods. The plants about to flower in short photoperiods were deprived of all shoots and transferred to long photoperiods. Such plants began first to form flowering shoots, but later " leaves began to appear as well, first small and irregular in shape, but later better developed and normal, with large green blades. Thus, the fruiting shoots were gradually converted towards the tips into vegetative shoots. If plants with such ' mixed ' shoots were again exposed to short photoperiods then the young growing tips of the axillary shoots again began to form flowers instead of leaves " (Cholodny, 1939).

Therefore the question as to reversibility or irreversibility cannot be regarded as even provisionally solved in one sense or another, although it must be admitted that the circumstantial evidence in support of irreversibility seems to be more securely based. Investigations of this question necessarily assume supplementary biochemical studies. The latter in turn, as has been pointed out, assume a detailed ecological knowledge of developmental phases and their succession. Until then we must refrain from any definite conclusion and still more from prejudiced interpretations; in short, to agree with the reviewer in the opinion that reversibility " has not been proved experimentally " and that the entire issue still remains an open question.

Biological Characters

The subsequent parts of the review (pp. 80-3) forming Chapter 7 are both scanty and incomplete. The objective at the time was not so much a desire to review the present state of certain biological problems as to illustrate the idea that the study of biological problems must hereafter be made with reference to the state of phasic development of the plant and its organs. Meanwhile, such questions as resistance to frost or drought are interesting not merely from the theoretical point of view. These properties in fact predetermine not only the suitability of a plant, but also the advisability of applying vernalization to a particular plant in one region or another.

The ten references dealing with the dynamics of frost and winter resistance are

reviewed in no more than ten lines. The idea is there, but further particulars are desirable, particularly in overcoming disadvantages brought about through vernalization, for instance, by an appropriate system of manurial treatment as suggested by Kuksa (1939). Moreover, it has been pointed out by some investigators (including Šestakov, 1938) that the ultimate frost resistance depends not only upon the phasic development, but also, and to a great extent, upon the ability of the tissues to harden; this ability increases during the thermo-phase and falls rapidly during the photo-phase. The physiology of resistance to frost and winter is not discussed, although there are several papers on this aspect.

Only one reference and two lines of the review are quoted on the resistance to drought, although this problem has been studied by many since Udolskaja (1937). Nothing is said regarding the physiology of drought resistance or of "pre-sowing hardening" of plants, the subject of many investigations during the past five years or so.

Nothing is said of resistance to fungous diseases, although this aspect was not neglected since Lysenko's report (1934); in 1936, Weideman published a paper on "the effect of vernalization on the susceptibility and resistance to fungous diseases, mainly *Puccinia simplex* Erikss. et Henn."

Except for some occasional and general remarks throughout the review, the significance of mineral nutrition was not considered, although this aspect has received ever-increasing attention before and since Abolina's investigation (1938); in 1939, Reimers reported on "the effect of soil nutrition on the development of the stage of vernalization in table beets and turnips". Each of these aspects is an extensive problem in itself and it is impossible here to review them satisfactorily.

Cytogenetic Concepts

The last three pages were devoted to a brief review of the genetical and cyto-genetical concepts advanced by Lysenko and Present, which have become the cause of an irreconcilable conflict among Soviet biologists. The main conclusions and concepts are quoted briefly, but incompletely, and deprived of factual materials. The division has become deeper and wider since 1935, and the differing parties now seem to be grouped more and more antagonistically, one around the Academy of Science and the other around the Academy of Agricultural Science with Lysenko as the President.

Very little was said of the method of "training of plants", (Lysenko, 1937), which virtually amounts to directed mutation on a large scale, and which has had quite a vogue among Soviet biologists and agronomists. "Reconstruction of the nature" of plants is being claimed from very diverse bases, including grafting (for instance, Lebedeva, 1937, Molotkovskiĭ, 1939, and others).

Here again one cannot fail to notice an undue exaggeration, or misunderstanding, in the presentation of experimental evidence. Some phenotypical changes cannot and must not be identified with alterations or readjustments in the genotype; some "deviations" in the behaviour of the first generation are little, if at all, convincing. Nevertheless, several papers can claim the conversion of spring plants into winter forms and of winter plants into spring forms as well as long-day plants into short-day forms and short-day plants into long-day forms; of particular interest is the paper by Razumov (1939) on the alteration of photoperiodical response in wheat and millet as a result of specially arranged "training of plants". On the whole, there are little or no grounds to doubt the efficacy of this method, but how far-reaching it will prove to be remains to be seen.

Darwin and Lysenko

A good many papers have been published on the effects and technique of the so-called method of intra-varietal crossing of self-fertilizing plants, of which almost nothing was said in the review ; here again, its efficacy and practical value can hardly be doubted, no matter what may be said of the theoretical premises ; this has been testified in many morphological and agronomical studies published during the last three or four years.

In this respect, Lysenko and his associates seem to follow, and, as it were, extend the studies of Darwin, (1900) who wrote : " As plants are adapted by such diversified and effective means for cross-fertilisation, it might have been inferred from this fact alone that they derived some great advantage from the process ", a view advocated some seventy-five years later by Lysenko and his associates. Summarizing his most comprehensive research on a scale never again repeated, Darwin (1900) wrote on " the constitutional superiority of the crossed over the self-fertilised plants " thus : " the first and most important of the conclusions which may be drawn from the observations in this volume is that generally cross-fertilisation is beneficial and self-fertilisation often injurious." This is exactly the conclusions and concepts as to " regeneration " advanced by Lysenko and his associates. Furthermore, Drawin (1900) wrote . . . " the advantages of cross-fertilization do not follow from some mysterious virtue in the mere union of two distinct individuals, but from such individuals having been subjected during previous generations to different conditions, or to their having varied in a manner commonly called spontaneous, so that in either case their sexual elements have been in some degree differentiated ", and still more clearly : " it is obvious that the exposure of two sets of plants during several generations to different conditions can lead to no beneficial results, as far as crossing is concerned, unless their sexual elements are thus affected ". Indeed, these quotations are quite sufficient to describe the principles and technique of the method of intra-varietal crossing, and perhaps also the leading principle of the training of plants, and to show whether Lysenko has returned to Lamarkism or to Darwinism. The results showing " the constitutional superiority of crossed over self-fertilised plants ", for instance, in growth vigour, seed yield, and, in many instances, earliness, claimed during the past five or six years by Lysenko and his associates are conspicuously similar to those published by Darwin in 1857 and the subsequent thirty-seven years. Thus, Lysenko's claims and concepts in this far-reaching field have a long and notable history, although it is not only in history that they find support.

The Scope of the Theory

Throughout this review we have attempted to stress the fact that the principles and concepts of the theory of phasic development are concerned " not only with the reproduction process as such, but also with all other co-participant and concomitant functions ", that is, the entire biology of plants. Such an extensive survey must necessarily remain outside the scope of this review, and would, in fact, be a somewhat presumptuous undertaking. Nevertheless, it must be admitted that since the announcement of the first hypothesis, the scope of the theory has extended rapidly far beyond the limits of a " mere modification of Gassner's chilling method ", and " in less than a decade, profoundly influenced the fundamental philosophy of plant growth " (Loehwing, 1939). In this rapid development it is now possible to outline the main fields for the further exposition and exploitation of the theory.

(1) Further investigations of the ecologo-physiological details of construction (succession) of sexual reproduction of various groups, genera, species and subspecies and biological races, having in view not only a more complete knowledge of the ecologo-physiological succession as such, but also a closer knowledge of the environ-

mental factors concerned with the vernalization of developmental phases, and the technique of vernalization. As has been pointed out repeatedly, this aspect, known in Soviet literature as "phasic developmental analysis" is the most urgent.

(2) The revision of biochemical and physiological studies within the framework of the theory, having in view not only a better knowledge of the internal mechanism of sexual development, but also the elaboration of a reliable and quick method of biochemical diagnosis. As has been pointed out in the review (pp. 58, 70 and elsewhere), the biochemical diagnosis of developmental phases has acquired considerable importance in relation to ecologo-physiological studies in sexual development.

(3) A revision of our present knowledge of biological characters such as resistance and endurance to unfavourable environmental conditions, photosynthesis, chemi-synthesis, nutrition, as well as morphogenesis in relation to the principles of phasic development.

(4) A revision, or at least reference to phasic development in cytogenetics and plant breeding. As pointed out by McKinney (1940), this will "not vitiate the fundamental postulates of evolution or of genetics" . . . . . . on the contrary, it may be hoped that "some of the confusion regarding the environment and inheritance will disappear". Of particular importance at this stage are the concepts relating to intravarietal breeding and genotypical readjustments of plants ("training of plants"). Undoubtedly, some cytogenetical bases will be, and must be found.

(5) The revision and reconstruction of certain agronomical practices, such as basic and additional mineral nutrition (having in view a fragmental and periodical supply of fertilizers), time of sowing particularly in relation to the purpose of cultivation, mass seed production and regional and seasonal distribution of varieties and crops; in short, agronomy and plant industry based upon the phasic development analyses of plants and vernalization, and the scope and method of vernalization in relation to the purpose of cultivation.

Naturally, with the rapid extension in the scope of the theory, friction with workers on the same and relative subjects has also increased, but this, it will be hoped, may prove to be of more constructive value in future years than it has been during the past decade.

Conclusion

With this we shall close our review which has dealt chiefly with the ecological and, to a less extent, the physiological aspect of the theory of phasic development. From this admittedly incomplete account, it can be inferred that, in spite of being in existence for ten years, the theory is still incomplete; without mentioning details, the very structure has many gaps. Meanwhile and despite this, "the concept of phasic development of plants has, in less than a decade, profoundly influenced the funadmental philosophy of plant growth as well as theory and practice in plant physiology, ecology, agronomy and genetics" (Loehwing, 1939).

Unfortunately, a correct evaluation of the significance of the theory in the further advancement of biology has not been accompanied by a correct interpretation and presentation of the fundamentals of the theory. This is a regrettably frequent occurrence, which explains the unsuccessful attempts of certain investigators (Gregory and Purvis, 1937-1938; Purvis, 1939; Vasiljev, 1939; Loehwing, 1939; McKinney, 1940; and others) to "modify" what they think is the theory of phasic development. In this respect the review "differs creditably from these attempts" (Bassarskaja, 1939) in giving perhaps not so strictly an impartial as certainly a candid account of "the facts and principles upon which the theory and practice of vernalization have been based." It is, as we said previously, an incomplete account, but the theory itself is incomplete; it is already out-of-date, but the theory is in a state of most rapid development.—M.A.O.

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SARATOV BOTANICAL INSTITUTIONS

In a short article (*Bot. Ž.* Vol. 24. 259-61. 1939), A. D. Fursaev has given an account " On the research of Saratov botanists ". The review is admittedly incomplete and is concerned only with recent researches which are now giving more or less definite results.

Botanical research in Saratov is concentrated chiefly at the State University, the Institute of Agriculture, Institute of Grain Husbandry (together with the Station for Plant Breeding and Genetics), the Zootechnical-Veterinary Institute and the Pedagogical Institute. Botanical research at some other institutions, such as the agricultural and horticultural stations, Agricultural High School and others, has been less prominent and is connected with research at one of the main centres.

State University

Department of Anatomy and Physiology (Professor N. A. Maximov) has been engaged in the study of multivarious effects of drought and physiological after-effects of irrigation on agricultural plants. Having no experimental fields of its own, the Department carries on field studies in co-operation with the Institute of Grain Husbandry and the Station for Plant Breeding and Genetics, and now, by agreement, on the fields of the experimental station of the U.S.S.R. Institute of Hydrotechnique and Amelioration at Engels.

In a series of studies on the colloidal-chemical properties of protoplasm as affected by drought and irrigation, the permeability of protoplasm was found to increase conspicuously during wilting ; this item is now being further investigated (L. D. Čistjakova) in close collaboration with the Institute of Plant Physiology of the Academy of Science, Moscow, particular attention being given to the viscosity of protoplasm and the degree of hydrophily of colloids. Alterations in the direction of saccharose activity in relation to wilting were investigated by A. D. Smirnova on the leaves of sunflower. The dehydration of leaves increased hydrolysis, whereas synthesis increased with resumption of water supply. These investigations will in future be extended to some other enzymes and first to proteases. The effect of high (super-optimal) temperatures on the direction of enzymatic activity is being investigated by L. A. Nezgovorov. S. B. Tageeva has been in charge of investigations on the effect of water supply on certain physiological processes in wheat under field conditions. A. V. Terenožkina investigated anatomical changes in sunflower leaves in relation to irrigation and found a conspicuous increase in mesomorphism, each watering leaving a marked impression on developing leaves.

Department of Systematics (A. D. Fursaev) has been engaged in the study of vegetation in the south-east of the European part of the Soviet Union, and its origins. Peat bogs were investigated by A. A. Čigurjaeva ; the method of pollen analysis made it possible to establish nine phases in the development of woodlands and to suggest that the present forest-steppe vegetation on the right bank of the Volga was

established in the sub-atlantic period and that the extension of forests began in the phase of large-leaved races, the oak being the pioneer among the latter. An extensive vegetation survey of the valleys of the Volga and Ural established an ecological sequence in various portions of the valleys and led to an assumption that forest in river valleys is one of the phases in the established sequence and has been in many cases followed invariably by grasslands. Some special features were also established in the vegetation of flooded land, such as high temperatures for germination, germination under water, duration of floods for certain species, dispersal of plants by flood waters, etc. In the vegetation of sand lands of the Volga and Ural (I. I. Hudjakov) it is possible to establish regions of sandy plants and the plant successions thereof. At the present time surveys are being extended to the vegetation of valleys of R. Hoper, R. Medvedica and of other rivers and to steppe vegetation on the right bank of the Volga, information on which has so far been very scanty; it was possible to establish some changes induced by cattle and rodents, for instance, increase in xero- and halophilous forms, and to suggest means of restoring the vegetation on fallow lands.

Institute of Agriculture

Department of Plant Physiology (Professor P. P. Smirnov) was engaged in investigations on physiology (photosynthesis and enzymes) of fruit trees in relation to agrotechnique (Kulagina) and on sugar content in bark and wood (L. N. Filimonova) in relation to fruit-bearing. New investigations initiated by Smirnov, who has been recently appointed, have not yet begun.

Department of Botany (M. M. Aleskovskiĭ) is in charge of many-sided research. M. N. Zaharjin has carried on a geobotanical survey of the northern part of the right bank of the Volga, near Saratov, special attention being given to steppes and woodlands and their relationship. M. Aleskovskiĭ investigated heterosis as a factor increasing yield in tomatoes; with irrigation he was able to induce a second flowering (August 18) in buckwheat. V. P. Mahlajuk studied the anatomy of apple trees as well as the vitality and germination of pollen. It was found possible to store the pollen in desiccators with calcium chloride without damaging its vitality, germination in sugar solution after two months storage being about 60 to 70 per cent. Unripe pollen ripened in the desiccators, this being more rapid in early than in late apple varieties. Investigations are in progress on the effect of the stigma on germination of pollen.

Department of Phytopathology (M. N. Rodinin) has published the first volume on the identification of fungi ("Fungi of cereal, grain legume, forage and technical crops"); the second volume is under preparation ("Fungi of vegetable and fruit crops"). A study of the micro-flora of *Carthamus tinctorius* was also completed. Certain new diseases were described; for instance, those induced in lucerne and sweet clover by *Bacterium radicipedra* Lav. A monograph on "Anthracnose of Cucurbitaceae" was also complied. V. D. Musanov completed research with the fungicidal properties of oil by-products; the disinfectant properties of acid tar were established.

Department of Vegetables (Professor V. K. Levošin) completed a monograph on *Prunus spinosa* in the dry regions of the lower part of Transvolga Province; a broad polymorphism was observed in both cultivated and wild forms and four distinct groups were established in respect of morphological and physiological (earliness) characters.

Zootechnical-Veterinary Institute

Department of Fodder Production (Professor P. P. Begučev) and *Department of Botany*) (N. G. Andreev) are collaborating closely in their research on fodder plants. P. Begučev has for several years studied a new forage plant, *Kochia prostrata* Schrad.,

which he introduced and which is now occupying a large area (over 1,000 ha.) in Kalmuckia. In his research which required botanical studies as well, he established four independent species in the south-east, each having its own specific area of distribution. The geography and distribution of *Kochia* were found to be connected in the north with phyto-coenological conditions and in the south with the boundary of snowfall. Its ecology, root system, developmental cycle, regeneration, reproduction and other items were also studied. As compared with some other plants, *Kochia* was found to show a beneficial effect on soil structure. At the present time, vernalization and photoperiods following vernalization are being studied ; it was possible to establish a definite relation between the yield of short-day plants and the maintenance after vernalization in darkness and in light ; an increase of grain yield by 30 per cent was obtained from oat plants after the treatment with darkness. The effect of various substances on plants was also studied ; for instance, treatment of oats for 6 to 12 hours in maize meal considerably increased the yield (40 to 50 per cent).

Andreev studied the ecology, anatomy and morphology of *Agropyrum ramosum* Trin. and established some variations (*viridis* and *salina*) ; in connexion with rational use of hay and pasture lands, the aftermath, height of mowing, dynamics of accumulation of organic matter, etc., were also investigated. Similar research has now begun with *Bromus inermis*, Leyss., and *Agropyron tenerum* Vas.

Institute of Grain Husbandry and Plant Breeding and Genetical Station

The character of the research at these institutions has changed considerably recently, and the information collected by Fursaev is incomplete. Professor L. I. Kazakevič, one of the oldest botanists in Saratov, was for many years engaged in research on weeds. He recently began studies of new agricultural crops. A. M. Jarkina has studied phytopathology (of wheats chiefly) in relation to irrigation. Infection of plants with brown rust was found to reduce the degree of assimilation and to increase the consumption of organic matter in respiration ; the fact that irrigation intensified this infection is thought to be due to increased photosynthesis in plants under irrigation, which provides optimum conditions for development and penetration (stomata opening) of this parasite in the plant body. Racial composition of rusts is now being studied.

Pedagogic Institute

Department of Botany (Tjumjakov) is of a recent origin, and research there has not yet been fully organized. In collaboration with the Department of Plant Systematics at Saratov University, F. I. Červjakov studied vegetation on the banks of the river Hoper.

* * * *

Recently the question was raised as to the organization in Saratov of a " neutral institution " for unification of botanical studies in a form of a section of the State Botanical Association and it is hoped that this institution will co-ordinate the research of Saratov botanists who are facing a stupendous task in connexion with the reconstruction of the Volga Province, irrigation of Trans-Volga regions and other studies in these very interesting, but little known, regions.

[It may be added that the research of the University has been published in " Naučnye Zapiski " which, as far as we are aware, are not available in Great Britain. The Institute of Grain Husbandry now publishes a periodical, " Soc. Zern. Hoz.", and the Station of Plant Breeding and Genetics its own " Trudy " ; the latter two publications are received in this Bureau. No other agro-botanical periodical or serial publication issued in Saratov is known to exist.]—M.A.O.

SCANDINAVIAN LITERATURE

PRODUCTION COSTS OF HAY LEYS

[REVIEWER: R. PETER JONES]

A recent book by E. Åkerberg and H. Winkler on the establishment, management and utilization of temporary leys is reviewed in *Herb. Abstr.* 10. Abs. 1100. 1940. This work, comprising Nos. 33 and 34 in Nordisk Rotogravyr's series of "Handbooks for Farmers" is designed for use not only by farmers, but also by agricultural students.

The contents of Chapters I to IV are given in *Herbage Abstracts*, but it has been considered desirable to present a full translation of Chapter V, dealing with the production costs of hay leys compared with those of other crops, as being a subject of particular current interest, especially in North America. The remaining paragraphs of this review are therefore a direct translation of Chapter V of "Temporary leys".

"We had hoped to be able to present material which would give a reliable picture of production costs of the harvest units obtained from the temporary leys in different parts of Sweden, in comparison with production costs of other fodder plant crops. As, however, every calculation of production costs is composed of estimated costs, material from a large number of farms would be required in order to obtain a reliable average representation. Sufficiently comprehensive material of such a kind is at present not available for Sweden.

"In order, however, to give readers an insight into the way such a calculation of production costs is worked out, we present one in the Table (35 in the original book).

"The material for this table, which was published by Nanneson, was obtained from the Swedish Grassland Society's two control farms, Blombacka in Västergötland and Boda in Värmland. The figures cited are averages for the three years 1934—36. As the data in the table are derived from two farms only, they have naturally no universal applicability, but hold good only under the conditions which prevail on the two farms. However, the data for consumption of labour, special costs, etc., indicate the approximate order of magnitude of these for the various crops.

"From Nanneson's commentaries to the table we will cite the following. The yield of the hay leys at the two control farms Blombacka and Boda is about 25 per cent more than that of the pasture leys. The hay leys have on the average of the three-year period yielded respectively 2,130 and 1,920 food units per ha., the pasture leys on the other hand respectively 2,630 and 3,490 food units per ha. The yields of root crops amount on the average respectively to 6,740 and 5,190 food units per ha.

"The consumption of labour per ha. of the hay ley amounts respectively to 95 and 114 man hours, together with 98 and 115 horse hours. Per ha. of the pasture ley it amounts respectively to 22 and 31 man hours, together with 13 and 27 horse hours. The corresponding consumption of labour per ha. of the root crop amounts to 510 and 600 man hours with 347 and 400 horse hours respectively. The figures quoted indicate that the consumption of labour was somewhat high for all the cultivations.

"Under the heading special costs have been entered direct costs for work, manure, seed, etc., for the different cultivations. Owing to the relatively low consumption of human labour and draught animal labour for the pasture ley, these costs are very low for this cultivation calculated both per ha. and per food unit.

Table 35.—Production costs of hay ley, pasture ley and root crop at Blombacka and Boda on the average of the years 1934-1936 (after Nanneson).

	Blombacka			Boda		
	Hay ley	Pasture ley	Root crop	Hay ley	Pasture ley	Root crop
Yield per ha., food units	2130	2630	6740	1920	2490	5190
Consumption of labour per ha.						
Man hours	95	22	510	114	31	600
Horse hours	98	13	347	115	27	400
Special costs per ha., kr.	170	83	713	154	82	713
Thereof human labour	40	9	213	57	15	303
Draught animals	36	4	126	30	7	108
Manure	51	64	345	36	52	248
General costs per ha., kr.						
Alternative I.	74	48	171	62	40	183
Alternative II.	88	88	88	75	75	75
Total production costs per ha., kr.						
Alternative I.	244	131	884	216	122	896
Alternative II.	258	171	801	229	157	788
Production costs per food unit, öre*						
Special costs	8.0	3.2	10.6	8.0	3.3	13.8
General costs I.	3.5	1.8	2.5	3.2	1.6	3.5
General costs II.	4.1	3.3	1.3	3.9	3.0	1.4
Total production costs per food unit, öre						
Alternative I.	10.6	5.0	13.1	9.9	4.9	17.3
Alternative II.	11.2	6.5	11.9	10.6	6.3	15.2
Do. relative nos.	172	100	183	168	100	241

*In the calculation of the production costs per food unit from the hay ley a deduction has been made for the value of the seed crop obtained, amounting to 19 kr. per ha. at Blombacka and 25 kr. per ha. at Boda.

Thus the special costs per food unit amount to only 3.2 and 3.3 öre (öre = approximately $\frac{1}{8}$d.) respectively for the pasture ley, compared with 8.0 öre for the hay ley and 10.6 and 13.8 öre respectively for the root crop cultivation.

" As general costs there has been entered for crop cultivation the share falling due of the costs for management, buildings, dead stock, general expenses, taxes and interest. A correct apportionment of these general costs among the different cultivations is a particularly difficult problem. The costs in question have according to Alternative I been apportioned taking into consideration the magnitude of the consumption of labour in the different cultivations, so that those cultivations which require more labour have been more heavily debited with the costs of management, dead stock and general expenses. According to Alternative II, on the other hand, the costs in question have been apportioned equally per hectare for all the cultivations. It is seen from the table that the calculated production costs are affected in a high degree both per ha. and per food unit by the basis of distribution of the general costs. This applies in particular in a comparison between cultivations which differ so greatly in labour requirement as the pasture ley and fodder root crop.

" Postulating Alternative II the production costs on the average of the three-year period are :

Per food unit from the
- hay ley .... 11.2 and 10.6 öre respectively
- pasture ley .... 6.5 and 6.3 öre respectively
- the root crop cultivation ...... 11.9 and 15.2 öre respectively."

PARAFFIN OIL FOR DANDELION CONTROL

[Reviewer: R. PETER JONES]

A few years ago, kerosene was tested in America as a means of combating dandelions, and appeared to be of value at any rate for grass swards. The method was tested during the winter of 1938-39 in the meadow plant department of the Swedish Seed Association to determine its usefulness under Swedish conditions (G. Nilsson-Leissner, *Svenska Vall- och Mosskulturförenigens Kvartalsskrift*, 2, 66-70, 1940).

Sprayings were carried out during the last days of September and the first days of October, 1938 on some old pasture grass plots which had been abandoned owing to the large number of dandelions occurring in them. On certain areas the number of dandelion plants was counted before spraying and also again on April 26, 1939. The experiment was conducted with three replications. The results of these counts are seen in summarized form in the accompanying statement, in which are also shown the grass species which were included in the several experiments. It is very clear

Grass stand.	*Kg. paraffin per 100 sq. m.*	*No. of dandelion plants*		*Difference*	
		in the autumn	*in the spring*	*number*	*per cent*
Poa trivialis	15.0	470	184	—286	—60.8
	7.5	335	207	—128	—38.2
	0.0	714	696	— 18	— 2.5
Poa species	10.0	790	560	—230	—29.1
	5.0	773	892	+119	+15.4
	0.0	992	1140	+148	+14.9
P. pratensis	15.0	1581	979	—602	—38.1
	10.0	932	710	—222	—23.8
	0.0	2332	3003	+671	+28.8
Lolium perenne	10.0	162	105	—57	—35.2
	0.0	186	167	—19	—10.2

that the dandelion stand was reduced on the sprayed plots, and that the reduction was more pronounced the larger the amount of paraffin oil used per unit of area. A still larger quantity, as for example 20 kg. per 100 sq. metres, which in certain cases was used in the American experiments, would undoubtedly have had a still better effect. For the elucidation of the tabulated statement it should also be pointed out that the action of 15 kg. in the rough-stalked meadow-grass experiment appears to have been more effective than the same amount in the smooth-stalked meadow-grass experiment. It should, however, be observed in this connexion that the number of dandelion plants in the unsprayed plots in the rough-stalked meadow-grass experiment had decreased by 2.5 per cent during the winter but in the smooth-stalked meadow-grass experiment it had increased by 28.8 per cent. If this difference be rightly taken into account, the reactions in both experiments are approximately equally great. The smooth-stalked meadow-grass plots were considerably older than the rough-stalked meadow-grass plots and contained, as is shown by the tabulated statement, very many more dandelion plants per unit of area. As a result of this undoubtedly too the number of ungerminated dandelion seeds in this case was much greater. The paraffin cannot gain the mastery over these before they

have begun to germinate. When counting in the spring it was unfortunately impossible to determine which plants were new that year and which had begun to grow before the spraying in the previous autumn. The number of surviving large plants on the sprayed plots was, however, in both experiments very small. It can, therefore, be considered as established that by spraying with paraffin, dandelions can be successfully combated but that in order to annihilate too the new seedlings originating in the spring the spraying should be repeated the following year also.

If then the dandelions clearly suffer severe injury from the paraffin, how do the other species in the grass sward respond to such treatment ? When as in the experiments described above spraying was carried out in cold and damp weather in the autumn, according to repeated ocular inspection as well as the yield figures of the following year, white clover is not injured at all. The *Poa* species (*P. pratensis*, *P. trivialis*, *P. palustris* and *P. nemoralis*) about a week after spraying exhibited some burning of the tips of the leaves, but in the spring they were quite healthy again and gave the same yield as the unsprayed plots of the respective species. Perennial ryegrass and lucerne, which were also treated with paraffin, were, on the other hand, completely destroyed. Unfortunately hitherto not many species of grasses and clovers have been tested in Sweden, while the American experiment referred to above was concerned in particular with *P. pratensis* and *P. compressa*, both of which held their own relatively well. Owing to the shortage of combustible oil during the autumn of 1939 the experiments were not repeated, as otherwise had been intended. Then all the species of meadow plants grown at Svalöf would have been tested. From experience obtained it is therefore possible at present to recommend paraffin spraying only on grass fields where the herbage consists preponderantly of the *Poa* species and white clover, while unfortunately it must be stated that the type of grass sward most common in south Sweden and in which perennial ryegrass predominates is not suited to this method of treatment.

The paraffin affects the dandelion plants in the following way. During spraying the leaves are covered with a layer of oil. This enters through the stomata and descends gradually into the root. Here it causes a coagulation of the milk sap, whereby the vessels are clogged and all transport between root and leaf is prevented. The plant is then doomed to die slowly. An inspection of the sprayed areas in the spring of 1939 revealed everywhere a number of narrow, deep holes in the ground, in which black, dried-up remains of dandelion roots could be observed. In some places, however, a few more or less severely injured roots survived, which were beginning to put out shoots again.

Although experience shows that great care must be exercised and that only in certain definite cases can paraffin spraying be practised, bearing in mind the great trouble which dandelions frequently cause in long-duration plots, it may be of importance that this new means of control should become more generally known. In cases where it can be employed it should be of assistance to those who wish to be freed from " the grass fields' yellow peril," which, particularly on certain soils, has a tendency to gain the ascendency in long-duration grass stands.

CONFERENCES

Conference on Herbage and Forage Crops, Moscow

The material from a conference on the breeding, seed production and agrotechnique of herbage and forage plants held at the U.S.S.R. Academy of Agricultural Science, Moscow, on January 7 to 12, 1938, has been published in the form of a symposium, edited by P. N. Konstantinov and A. K. Zubarev. Twenty-three reports appeared under the following three groups. (1) Cultivation of red clover (ten papers), (2) Cultivation of lucerne (five papers), and (3) Hay and pasture crops (eight papers). The last group deals with annual and perennial grasses, and their cultivation in mixtures with lucerne and lucerne varieties.—M.A.O.

Conferences on Desert Reclamation, Moscow

The proceedings of the first plenary session of the USSR. Academy of Agricultural Science on reclamation of deserts, sandy lands and highlands held in Moscow on Feb. 10 to 15, 1938 [cf. *Herb. Rev.* 7. 139-40] have now been published by USSR. Academy of Agricultural Science in Moscow. The publication, edited by B. A. Keller, A. G. Gael and I. P. Podlepič, contains nineteen papers and the resolutions which were passed. Those reports published earlier elsewhere were not, however, included in this publication. In addition to the reports mentioned previously, the following may be noted :—

A. M. Alpatjev (Aral Station of the USSR. Institute of Plant Industry, Chelkar) reported on " irrigation and efficiency of fertilizers in sandy deserts of Aral region ", summarizing results of three years' investigations ; a dependence of expenditure of water upon the rate of accumulation of organic matter, and an analogy between various plants during the period of maximum consumption of water could be established in these investigations.

" The problems of irrigation and water supply to deserts and semi-deserts of U.S.S.R." were discussed also by A. N. Kostjakov, who reviewed water and land potentialities for the main deserts with special reference to their irrigation by overground and underground waters.

V. A. Balmont (Kazakistan Institute of Animal Breeding) dealt with " the problems of qualitative improvement of animal industry in deserts and semi-deserts of Kazakistan ". E. A. Kalašnikov described methods of cultivation of " water-melons in Kara-Kum ", which were tested at the experimental stations at Repetek and Karabogaz.

E. P. Korovin (Central Asian University, Tashkent) reported on " the first experiments of agricultural reclamation of deserts in Uzbekistan ", and on the methods of improving grassland vegetation in deserts. M. S. Kolinov gave an agricultural evaluation of " natural fodder lands in northern Aral Region ", which are chiefly represented by grass-*Artemisia* steppes, stressing the palatability of *Artemisia astrachanica* throughout its vegetative season.

L. N. Sablukov reported on the economic problems of further " reclamation of semi-deserts of Kalmuckia ". G. A. Zinovjeva (Turkmenian Station of Animal Breeding) summarized " the results and prospects of research on agricultural reclamation of deserts in Turkmenia ", including fodder production, the use of underground water and sand binding. K. G. Telešek (Exp. Sta. Cjuripa, Ukraine) summarized the " reclamation of lower-Dnieper sands " before the Revolution and outlined the research at the Station ; vast possibilities exist for the reclamation of sand by intensive cultivation within tree shelter belts. A. G. Gael and E. S. Ostanin presented a long paper on results obtained during two expeditions to " South Kazakistan sand massif Muyun Kum " which appears to have great potentialities for the development of agricultural, forestry,

fishery and other industries. More details of these papers will be found in current issues of *Herb. Abstr.*

* * * *

The second Plenary Meeting at the USSR. Acad. Agric. Science, on reclamation of deserts, sandy lands and highlands was held in Moscow, on Feb. 7 to 11, 1939 (I. V. Larin, *Bot. Ž.* Vol. 24. p. 262). The Meeting discussed the problem of reorganization of the Session (I. V. Larin, Botanic Institute of Academy of Science, Leningrad), and revised the research items of some institutions now working in Soviet deserts (P. A. Baranov, Central Asian State University, Tashkent). For many years the reclamation of deserts and sandy lands has been carried out spontaneously by a number of institutions directed independently from the Bureau of Deserts at the USSR. Institute of Plant Industry (a leading Institute in the system of research institutions of USSR. Academy of Agricultural Science), National Commissariat of Agriculture of four Central-Asiatic republics and Kazakistan, Botanical Institute of the Academy of Science and Kazakistan Section of the Academy of Science. It was decided for this reason to amalgamate scientific guidance at an Institute of Agricultural Reclamation of Deserts, Sands and Highlands to be specially opened for this purpose in Tashkent. The Institute will amalgamate the following six research stations :—

(1) Kara-Kum Station of the USSR. Institute of Plant Industry at Repetek ; reclamation of sandy lands of southern type ;
(2) Kyzyl-Kum Station of Central Asian University ; grassland problems on clay and sandy deserts of southern type ;
(3) Aral Station of the USSR. Institute of Plant Industry at Chalkar ; sandy deserts of northern type ;
(4) Balkhash Station, to be opened jointly by the Academy of Science and USSR. Institute of Plant Industry ; " greening " and vegetable industry ;
(5) Central Kazakistan Station, to be opened at Dzhezkazgan jointly by the Academy of Science and Kazakistan Institute of Agriculture ; reclamation of clay deserts of northern type ;
(6) Pamir Station of Academy of Science ; reclamation of highland.

The Institute will also direct all the plant breeding researches in some other institutions now working within the territory of Kazakistan, Tajikistan, Uzbekistan, Turkmenistan and Kirghizistan, irrespective of their administrative position. As the new Institute will be in charge of research at institutions of the USSR. Academy of Agricultural Science and Academy of Science, the Plenary Meeting instructed that this Institute should be organized jointly by both Academies. —M.A.O.

Australia and New Zealand Association for the Advancement of Science

The Report of the twenty-fourth meeting held at Canberra, Jan. 11 to 18, 1939 (pp. 455), contains the following contributions.

SECTION K.—Agriculture and Forestry.

W. L. Waterhouse : Some aspects of plant pathology. (Presidential Address.)

Sir E. John Russell : Soil conservation and permanent agriculture.

Symposium on pasture problems of Australia and New Zealand.

(See *Herb. Rev.* 8. 32-4. 1940.)

Richardson, A. E. V. : Pasture improvement.

Trumble, H. C. : Climatic control of herbage plants in southern Australia.

McTaggart, A. : The areas of Australia in which the establishment of exotic plants is or seems to be practicable. (Published in *J. coun. Sci. industr. Res. Aust.* 12. 151-4.)

McMillan, J. R. A. : The problem of improved strains of pasture plants.

Davies, J. G. : Pasture management problems.

Fricke, E. F. : The influence of grazing management on the carrying capacity of a newly sown pasture. (Published in *Tasm. J. Agric.* 10. 57-62.)

Joint discussion on soil erosion.
Opened by Sir E. John Russell.

Holmes, Macdonald: The artificial stimulation of soil movement. (Published in *J. Aust. Inst. Agric. Sci.* 5. 84-9.)

Ratcliffe, F. N.: Erosion in arid areas.

Prescott, J. A.: Soil type in relation to erosion.

McDonald, A. H. E.: Soil fertility and tilth in relation to soil erosion. (Published in *Agric. Gaz. N.S.W.*, 50. 117-20.)

Clayton, E. S.: The erosion problem and mode of attack.

Wood, J. G.: Regeneration of plants in the arid eroded areas.

Lane Poole, C. E.: Correction of erosion by afforestation.

McTaggart, A.: Grass types, suited to soil erosion control. (Published in *J. coun. Sci. industr. Res. Aust.* 12. 155-7.)

SECTION M.—Botany.

Wood, J. G.: The plant in relation to water (Presidential Address).

Brooks, F. T.: Some recent investigations on epidemic plant diseases.

* * * *

Other papers read:

Amos, G. L.: Some aspects of the carbohydrate metabolism of grasses.

Ashby, E.: The genetic determination of size in plants.

Barrien, Miss B.: Sulphur metabolism of plants. (Summary of papers by Wood, J. G., and Barrien, B. S. *New Phytol.* 38. 125-49, 257-64, 265-72. 1939.)

Blake, S. T.: The inter-relationships of the plant communities of north-eastern Australia.

Eardley, Miss C. M.: Contributions towards a flora of Central Australia—routes of some exploring expeditions of which there are plant collections in the Adelaide University Herbarium.

Greenham, C. G.: The wetting of plant surfaces.

Petrie, A. H. K.: Export of nitrogen from leaves in relation to senescence.

Pidgeon, Miss I. M.: Plant succession in the Sydney district.

Roe, R.: Plant succession on wind-eroded red soil areas in the Maranoa District (Queensland).

Turner, J. S.: Some aspects of plant respiration. (From papers published in *New Phytologist*, 36. 1937.)

Williams, R. F.: The analysis of growth rate in plants.

Forest Service Range Research Seminar

The collection of adequate information on grassland agriculture is becoming increasingly urgent in the United States. As part of this programme, a conference of major interest was held from July 10 to 22, 1939, at the Great Basin branch of the Intermountain Forest and Range Experiment Station, near Ephraim, Utah, by the U.S. Forest Service, to take stock of objectives, plans, procedures, and technique applicable to range research problems.

Full details are given in *J. Amer. Soc. Agron.* 32. 235-8. 1940.—R.O.W.

Seventh Alfalfa Improvement Conference

Meetings of this Conference are held in alternate years in conjunction with the meetings of the American Society of Agronomy. The Seventh Conference was held at New Orleans on Nov. 22, 1939 (Chairman: H. M. Tysdal), and a mimeographed report has been prepared by H. L. Westover, the permanent secretary.

The Conference opened with a report by H. L. Westover summarizing the results of the uniform nurseries. For the benefit of those who had not attended previous conferences, it was explained that the improvement programme started about ten years ago, the main objective being

the development of an alfalfa resistant to bacterial wilt and desirable in other respects. Under this programme several resistant strains have been developed and the next step has been to determine their adaptation to various environmental conditions. With this in mind, the so-called uniform alfalfa nurseries were established in co-operation with State experiment stations.

The preliminary results regarding the wilt resistance of the new strains as compared with standard varieties agree rather closely with those obtained under controlled conditions, and consideration is now being given to increasing the more promising strains.

The next step on the programme of the Conference was the presentation of statements of the progress in breeding by several men who have been particularly interested in the breeding programme. Reports were received from B. A. Madson, California ; T. M. Stevenson, Canada ; R. M. Weihing, Colorado ; C. O. Grandfield, Kansas ; E. E. Down, Michigan ; H. M. Tysdal, Nebraska ; H. B. Sprague, New Jersey ; C. H. Myers, New York (Cornell) ; R. A. Brink and W. K. Smith, Wisconsin. These reports cover pages 2 to 15 of the publication and give a most useful cross-section of alfalfa improvement in U.S.A. and Canada at the present time.

Following these reports, a round-table discussion was held on the question of the increase and distribution of new alfalfa varieties. After L. F. Graber (Wisconsin) had given some opening remarks to present the problem, observations were made from the seed producing, seed consuming, State, certificate and Federal standpoints by E. R. Jackman (Oregon), R. D. Lewis (Ohio), R. J. Throckmorton (Kansas), R. D. Mercer (Montana), and H. L. Westover (U.S.D.A.).

The Nominating Committee (Chairman : O. S. Aamodt) then nominated the following to serve as members of the Executive Committee of the Conference for the ensuing two years. L. F. Graber, Wisconsin (Chairman) ; B. A. Madson, California ; R. M. Weihing, Colorado ; and C. O. Grandfield, U.S.D.A. and Kansas.

As an appendix to the Report, D. W. Robertson of Colorado presents some observations made at Aberystwyth on methods used in strain building in *Lolium perenne*.—R.O.W.

Central Fodder and Grazing Committee, India

The third meeting of the Central Fodder and Grazing Committee was held on the 30th November, 1939 (see *Herb. Rev.* 7. 41. 1939). The following items were considered :—

(1) *Plantation of fodder trees.*

In the United Provinces a special officer had been appointed to encourage the plantation of trees to produce fodder and fuel for the villagers. His efforts had met with considerable success and the question of legislation to permit control of all waste lands was under consideration. Meanwhile propaganda was being carried on. A somewhat similar system was proving successful in Madras. It was pointed out that the most important matter was to investigate the relative nutritive value of grasses and fodder trees to find out how far the plantation of fodder trees was an economical proposition. In Bombay the plantation of fodder trees was not encouraged, as it was considered that if the cultivators would find a cheap and easy food for cattle from trees, they would not take the trouble of providing against periods of scarcity by storing grass or other fodders which were decidedly superior for cattle feed. Babul (*Acacia arabica*) was proving useful as a scarcity fodder in Sind and the Government were giving concessions for babul plantations. There was, however, urgent need to try some quick growing trees like shevri (*Sesbania aculeata*) which was proving a useful plant for the dry regions. It was observed that no information was available regarding the quantity of fodder tree loppings required per animal. The Committee has been informed that from the point of view of chemical analysis the loppings of trees like shisham (*Dalbergia sissoo*), peepal (*Ficus religiosa*), ber (*Zizyphus jujuba*) and acacia were in certain respects equal to wheat bhusa and it was worth while encouraging their plantation, especially in arid areas. The Committee finally recommended the plantation of fodder trees in arid regions where there was a scarcity of grasses and suggested that in respect of other areas experiments should be carried out to ascertain the yield and nutritive value of fodder trees and the number of cattle that could be maintained per acre therefrom and to determine the best lopping technique.

(2) *Reports on the work of Provincial and State Fodder and Grazing Committees.*

It was pointed out by the Bombay representative that the present system of working by the Provincial Committees was not likely to lead to any useful results. There should be some executive body either at the centre attached to a suitable Institute or in the Provinces to see that the work was carried out properly. No such difficulty was however experienced in certain provinces such as the Punjab and the United Provinces where work was carried on smoothly on the recommendations made by the Provincial Committees and no such necessity of an executive control arose. The Committee felt that the only effective way of ensuring that action was taken on the recommendations of the Provincial Committee was to draw the attention of the Provincial Government and the Department concerned to the matter.

(3) The desirability and feasibility of storing grass for long periods against years of bad rainfall were discussed. Reference was made by the Livestock Expert to the Government of Bombay to a plant devised and worked by him for artificial drying of green grass in young condition when it was very nutritious. The plant was simple to work, cheap and portable and the moisture content of the fresh grass could be reduced from 70 to 7 per cent during the monsoon period when under ordinary conditions it was difficult to dry the grass. The plant could dry grass at the rate of 3 cwt. per hour and was considered quite a suitable piece of machinery to cope with the large quantity of grass available during monsoon. Grass cut at short intervals was an ideal food for cattle as it provided a fairly rich source of protein. The Committee therefore recommended that the apparatus be given a trial. Some members considered that silage making was the best method of preserving cattle food. The Committee also generally agreed that the preparation of silage should be encouraged, but it was held that this method, owing to transport difficulties, would not help to solve the problem of fodder supply in years of famine and it was therefore necessary to arrange for the storage of fodder which would be available in times of need.

(4) The Committee considered a note by the Agricultural Commissioner with the Government of India on the present position and future requirements of anti-erosion work in India and recommended that a sub-committee of the Central Fodder and Grazing Committee be constituted to formulate concrete proposals for carrying out co-ordinated work on this problem.

The Committee also considered schemes on Mixed Farming from the United Provinces, North West Frontier Province, Sind and Orissa, and approved of a standard scheme which could be applied throughout India with modifications to suit local conditions.

Association of Agricultural Research Workers in the Northern Countries

The Danish section of the Nordiske Jordbrugsforskeres Forening (the Association of Agricultural Research Workers in the Northern Countries) held its ordinary general meeting at Copenhagen on December 6, 1939 (*Nord. JordbrForskn.* 21. 447-8. 1939).

H. N. Frandsen, Øtoftegaard, reported that it was intended to form a union of Danish plant breeders and asked whether such a society could be organized in association with the Danish section of the N.J.F. The General Secretary replied that the N.J.F. regarded such co-operation with favour as far as the economic position of the Association permitted. Possibly the Finnish sub-sections might serve as a model for such an organization. He suggested that further consideration should be given to the matter, to which the meeting assented.—R.P.J.

South African Association for the Advancement of Science

The thirty-eighth annual meeting is to be held in Salisbury, Southern Rhodesia, from July 10 to 16, 1940. The proceedings will be published as usual in the *South African Journal of Science.* —R.O.W.

ANNOTATIONS

Great Britain (410)

Grassland Improvement Station

A heavy grassland farm, typical of millions of acres in Britain capable of far higher productivity, has been taken over by the Ministry of Agriculture as a Grassland Improvement Station. Sir George Stapledon will undertake its direction.

The centre consists of two adjoining farms, Drayton and Dodwell, two and a half miles from Stratford-on-Avon on the Stratford-Evesham road. They consist of 600 acres of heavy clay in poor condition, and the demonstrations will endeavour to show how to turn them into first-class farms again on an economic basis. In addition to this long-term treatment, however, an essential objective is to show methods that can be applied to grow more food on the farms in war-time, and the station will act as an advisory centre for the country as a whole.

Three methods of treatment are proposed : improvement as permanent grass by various methods short of ploughing ; farming by rotating temporary grass with arable crops ; ploughing and immediate reseeding.

Professor F. G. Gregory

It is announced in *Nature* that Professor F. G. Gregory, D.Sc., of the Imperial College of Science and Technology, London, was elected a Fellow of the Royal Society at a meeting of the Society held on March 14, for his distinguished research on the analysis of plant growth, especially in relation to mineral nutrition and vernalization.

Studies directed by Professor Gregory at the Institute of Plant Physiology on the effect of environmental conditions, chiefly temperature and photoperiods, can be traced back to the year 1930 ; in 1932, Miss O. N. Purvis began her research, which was later summarized in 1934 (**2**). These early environmental studies were, however, based on the so-called chilling method, an outcome of Gassner's research (1918). Environmental studies acquired a more definite trend since the International Botanical Congress in 1935 when Professor Gregory made his first report on vernalization (**3**). The most important contributions on the subject were published, in collaboration with Purvis, in *Nature*, in 1936 (**6**, **7** and **8**), and these were followed by a series of papers in collaboration with Purvis, Nutman and Ropp (**12, 13, 14, 17, 18, 19**), and by reports to the British Association in 1938.

Perhaps the most important contribution was on the vernalization of seeds during ripening, established independently of Kostjučenko and Zaruballo (1935), in research with Petkus winter rye (**7**). The significance of this discovery cannot be over-estimated and it may well prove to be a turning point in the history of ecological studies.

Another important contribution was the possibility of vernalizing an excised embryo (**6**), which was confirmed by other investigators including Konavalov (1937) and Buslova (1938). This was followed by interesting studies on the localization of the active region of the embryo under vernalization, partly published by Purvis (**20**), and the current research on grafting of fragments of vernalized and unvernalized embryos. The number of leaf hypothesis was still another outcome of these studies. Other speculative concepts include the " devernalizing " effect of high temperatures, and the hypothetical scheme of succession of physiological principles of initial stages of plant development, including vernalization. It must be noted that by vernaliza-

tion, Professor Gregory understands only the pre-sowing treatment of germinating plants or plantules before the initiation of floral primordia.

The following references are not necessarily a complete list.

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4. ——— 1936. The effect of length of day on the flowering of plants. *Sci. Hort.* 4. 143-54.
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9. ——— 1937. Devernalization of spring rye by anaerobic conditions and revernalization by low temperature. *Nature, Lond.* 140. 547.
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19. NUTMAN, P. S. 1939. Studies in vernalization of cereals. VI. The anatomical and cytological evidence for the formation of growth-promoting substances in the developing grain of rye. *Ann. Bot., Lond.* 3. (n.s.) 731-57.
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Germany (43)

Research Station of Alpine Agriculture, Admont, Styria

The Minister for Nutrition and Agriculture, with the support of the Reich Minister of Finance, has authorized the foundation of a Reich Research Station of Alpine Agriculture at Admont, in Styria. Its aims are described by Dr. R. Geith in *Forschungsdienst.* 8. 375-6. 1939. The work envisaged is the study of alpine agriculture and of its economic bases, and the discovery of means of improving its efficiency, the area to be embraced including all the alpine regions of Germany from the Bodensee [Lake of Constance] to the foot of the Alps in the east of the Ostmark [Austria] and from the Italian frontier into the Bavarian Alps. It is realized that alpine and valley farming are, strictly speaking, inseparable, and for this and other reasons the locality chosen, Admont, appears to be eminently suitable. " With a total area of approximately 760 hectares, Admont appears to furnish the most favourable conditions for the carrying out of a great diversity of experiments and studies. Approximately 300 hectares are situated in the

broad valley of the Enns at an altitude of 650 to 700 m. High moor and transition moor alternate with mineral soils. In spite of high rainfall and relatively long winters, arable farming is quite possible. When suitable varieties are selected, wheat, rye, barley, oats, potatoes and turnips can be grown. A mountain farm of about 120 hectares is situated at an altitude of 1,100 to 1,300 m. Here also, in the parts having a southern aspect, there are areas which permit the growing of cereals and roots. There is thus furnished a most favourable opportunity for testing and breeding at high altitudes resistant varieties for mountain farms. The rest of the Station's area consists of an alpine estate which reaches an altitude of 2,100 m.

There is often a tendency to regard the alpine region as a purely grassland region, which, from a statistical point of view, is entirely correct, the proportion of grassland being from 90 to 95 per cent. But careful examination of the conditions in Austria shows that, even at altitudes of as much as 1,800 m., the growing of cereals and roots also has an assured place." For this reason the new Station will consist not only of a Grassland Institute, but also of an Institute of Arable Farming and Cropping and of a third to deal with stock-raising problems. In addition to questions of climate, soil, manurial treatment and breeding, machinery and labour-saving devices will be studied.

In all this it will be possible to begin where a great number of individual workers have left off, to co-ordinate and build up on the foundations they have laid. Tribute is paid to the pioneer work, among others, of the Swiss scientists Schroeter, Stebler, and Volkart, and the Austrians Weinzierl, Trubrig, and Schuppli.—G.M.R.

U.S.S.R. (47)

Research on Forage Plants

In order to study and test wild and cultivated forage plants, a comprehensive system of zonal nurseries has been organized at the experiment stations of the U.S.S.R. Institute of Plant Industry, as well as, by agreement, at some other institutions. The first period of this work may now be regarded as completed, and E. Sinskaja, who is in charge of the researches, discusses the present position in a short review (*Bot. Ž.* Vol. 24. pp. 95-6. 1939), which is given in a condensed form below.

During this period comprehensive researches were carried out on the agro-ecological classification of materials collected at the U.S.S.R. Institute of Plant Industry, Leningrad, and the U.S.S.R. Institute of Fodders, Lugovaja (near Moscow), Siberian Institute of Grain Husbandry, Omsk, and some other centres. When tested under different conditions the established ecotypes of Gramineae and Leguminosae proved to be fairly stable, at least in morphological characters, but the ecotype populations responded readily to changes in environmental conditions, each reacting in its own particular way. Some characters varied little, while others varied so broadly that in some instances the reactions were reversed. For instance, northern European ecotypes of *Medicago falcata* L. were the earliest flowering forms when tested in the environs of Moscow and Omsk, and the latest when tested in North Caucasus. The greatest degree of plasticity, that is, the greatest adaptability to conditions of growth, was shown by ecotypes from the highlands of Caucasus and Altai. On the contrary, the semi-desert forms from South Kazakistan were of fixed constitution, and in many cases showed little winter hardiness.

The Caucasus were found to be the centre of diversity for many species of lucerne, clover, sweet clover, vetch, *Phleum*, *Dactylis*, and *Festuca*; many-sided studies of these genera now in progress promise to yield interesting and practical conclusions. Investigations of the genus *Medicago* are perhaps in a more advanced state. The ecotypes of *M. sativa* L. showed conspicuous differences in the length of the photo-phase, the mountainous and northern ecotypes having a longer photo-phase than those from valleys of southern latitudes. Some of the ecotypes were found to possess a definite hereditary range of variation in chemical constitution, and a specific

variation in chemical composition proved to be related to changes in environmental conditions. Nevertheless, it was possible to outline certain regularities, for example, all ecotypes should show an increased content of protein and fibre with progression southwards.

At the same time as the stationary studies, expeditions were continued ; much new material was added to the collection grown at the nurseries, the location of swards of forage plants suitable for seed production purposes was noted. In 1936, extensive swards of *M. falcata* were found in the foothills near Maikop, North Caucasus. In Daghestan, a zone of distribution of *M. hemicycla* was found, which species has so far been regarded as endemic for Transcaucasus ; a new form of blue-flowering lucerne (resembling *M. Trautvetteris* Sumn. but more hydrophilous) was also found there. In Karachai, Azerbaijan, some species of yellow-flowering forms, intermediate between *M. glutinosa* and *M. falcata* were found with abundant leaves, of some fodder value. New materials were provided by expeditionary and stationary studies which facilitate the continuation of the study of the phylogenesis of the genus *Medicago* and other genera begun some time ago. [*Herb. Abstr.* 6. 262. 1936 ; 7. 207-8, 208, 1937 ; 8 Abs. 286, 1416.]—M.A.O.

U.S.S.R. Agricultural Exhibition, 1939

A fully illustrated volume presents a popular description of the Main Pavilion, twenty-one regional and twenty-five sectional pavilions, and three demonstration allotments with plantations of 260 plants (over 3,000 varieties) in the Agricultural Exhibition opened on August 1, 1939, in Moscow (edited by P. N. Pospelov, A. V. Gricenko, and N. V. Cicin. 1939. 24×14. pp. 616). The book contains also the laws regarding agricultural exhibitions sanctioned by the Supreme Council of U.S.S.R., official regulations and resolutions by the Government and the Party, and an article by N. V. Cicin on the agricultural exhibition, its main features and significance in the history of Soviet Agriculture.

The Exhibition covered about 130 hectares ; 230 buildings of various sizes and pavilions were permanently erected for exhibits from 850 collective farms (Kolkhoz), 195 state farms (Sovhoz), 62 machine-tractor stations (MTS), and 95 research institutions. The Russian S.F.S.R., with her seventeen autonomous republics and autonomous regions, occupied eleven pavilions. There were also two artificial lakes for fishery exhibits, while 80,000 bushes, 40,000 trees and over 4,000,000 flowering plants were planted to indicate the achievements of agriculture and horticulture, as well as to decorate the Exhibition. Over 183,000 agricultural exponents of all grades, of which 155,000 were delegates of rural husbandry and agricultural science, participated in the exhibition, while in the course of the first month about 5,000,000 people visited it from all parts of the Union.

For the guidance of visitors the Supreme Council of the Exhibition published 44 guide books for the pavilions and the exhibition grounds (10 of these have been received at this Bureau), 72 monographs (of which 48 were concerned with various branches of plant industry) summarizing the agricultural achievements of individual farms, regions or individual branches of rural husbandry, and 500 booklets (272 on plant industry) in which the exhibits and outstanding methods of rural husbandry are described. Finally, an official organ of the Supreme Council of the USSR. Agricultural Exhibition, namely, *Bull. Glav. Kom. Vsesojuz. Seljskohoz. Vystavki*, was issued. Of this publication, only Nos. 19-25 inclusive, 1939, have been received at the Bureau.

The Exhibition was organized and directed by the Supreme Council, presided over by I. A. Benedikov, the Director of the Exhibition being N. V. Cicin. The Exhibition was opened by V. M. Molotov, the head of the USSR. Government.

The plan and regulations for the collection of agricultural exhibits for 1940 were approved by the Supreme Council in September, 1939. As in the earlier year, the participation of various farms in the Exhibition during 1940 was conditional upon a definite standard of farming being reached.—M.A.O.

Publications of the Ukrainian Academy of Science

The Presidium of the Academy of Science of Ukrainian S.S.R. has approved the list of twenty-

four journals to be issued in 1940 (*Visti Akad. Nauk URSR.* Nos. 6/7. 1929 and No. 9/10. iii. 1939), which includes the following periodicals:

Visti Akad. Nauk URSR. (10 issues; Roubles. 15.0).
Dopovidi Akad. Nauk URSR. (12 issues, R. 24.0).
Biohim. Ž. (6 issues; R. 30.0).
Mikrobiol. Ž. (4 issues; R. 28.0).
Bot. Ž. (4 issues; R. 28.0) (formerly *Ž. Inst. Bot. AN. URSR.*).
Geobot. Sbirn. (one issue; R. 7.0).
Zbirn. Prac. Morfolog. Tvarin (one issue; R. 7.50).
Zbirn. Prac. Zoomuz. (one issue; R. 7.50).
Zbirn. Prac. Ekolog. Tvarin (2 issues; R. 14.0).
Zbirn. Prac. Genet. (2 issues; R. 14.0).
Trudy Gidrobiol. Sta. (4 issues; R. 28.0).
Trudy Karadag. biol. Sta. (one issue; R. 7).
Probl. Soc. Gospodar, URSR. (*Zap. Inst. Ekonom.*). (4 issues: R. 20.0).

The inquiries re subscription should be sent to the Publication Office, Acad. Sci. Ukr. S.S.R., 2,ul. Čudnovskogo, Kiev, or to Mezdunarodnaja Kniga, 18, Kuznetckiĭ Most, Moscow, or through the Ukrainian Association for Cultural Relations with Foreign Countries, 44, ul. Meljnika, Kiev.—M.A.O.

Scientific Brigade of Ukrainian Acad. Sci. in Lwow.

Following the instructions of the Presidium of the Academy of Science in Ukrainian S.S.R., a group of scientists with Academician A. V. Palladin at the head arrived at the former Polish city of Lwow, West Ukraine (*Visti Akad. Nauk URSR.* No. 6/7. 130. 1939). The brigade was acquainted with the details of the research at Taras Švečenko's Scientific Association in Lwow and at various laboratories of Lwow University, in order to include these scientific centres in the zone administrated by the Academy of Science in Kiev. In a number of reports, the brigade in turn acquainted the Lwow scientific circles with research at various institutions of the Ukrainian Academy of Sciences and Kiev University.—M.A.O.

V. R. Williams (1863-1939)

The Soviet agricultural press has announced the death on Nov. 11, 1939, of Vasiliĭ Robertovič Williams, Member of the Academy of Agricultural Science, Moscow.

Academician Williams was born in October, 1863, to the family of an American railway engineer, Robert Williams, who emigrated in 1854 from U.S.A. and died in 1874, leaving his family almost without means of support. Academician Williams was thus well acquainted from a tender age with the hardships and needs of life, being the only supporter of the family of seven while still hardly twenty years of age. In 1887 he graduated at the Petrovskoe Agricultural Academy, Moscow, and began a most active and successful career, his jubilee being solemnly celebrated throughout the U.S.S.R. in 1934. The day before his death he sent to press his last contribution to his native and much indebted agriculture; in this he summarized twenty-two years of Soviet agronomical researches and outlined further research items to Soviet agricultural institutions.—M.A.O.

S. A. Nevskii (1908-1938)

Unnoticed by the international botanical press during the troubled summer of 1938, the death occurred on July 2 of Sergeĭ Arsenjevič Nevskiĭ, Senior Agrostologist at the Botanical Institute of the Academy of Science in U.S.S.R., Leningrad. Not until twelve months later did an obituary appear in *Sovet Bot.* 1939. No. 5. pp. 126-7, upon which the present notice has been based.

S. A. Nevskiĭ was born on September 24, 1908, at Troickoe-Boljšoe, a village in the Tver Province. In 1927, he graduated at the Tver Pedagogical Institute and two years later, on the

recommendation of Professor A. P. Iljinskiĭ, he took an active part in an expedition to the southern Urals. In November of the same year, he was appointed as a junior agrostologist to the Principal Botanical Gardens (now Botanical Institute), where he worked fruitfully and steadily despite his poor health until his premature death in 1938. Suffering as he did from tuberculosis, S. A. Nevskiĭ could not endure the inhospitable climate of Leningrad, and died three months before his thirtieth birthday. Agrostological and taxonomic science suffered thereby an irreparable loss.

As early as 1930, he published his first investigation "On a new species in the genus *Agropyrum* Gaertn ". (**1**) ; further investigations in this genus (**2, 3,** and **4**) revealed the necessity for a revision of the entire genus, and in 1932 he published his first large contribution " On the systematics of the genus *Agropyrum* Gaertn ". (**5**) which was adopted by many investigators. This was soon followed by still larger investigations " On the systematics of the tribe Hordeae Benth " (**8**) in which he presented an entirely new system for the tribe and its position in the Gramineae. It seemed to him necessary to separate the genus *Nardus* into a new tribe Nardeae closely related to the tribe Festuceae, and to bring closer the tribes Leptureae and Andropogoneae ; in the phylogenesis of the Gramineae, he shared the view that paniculated inflorescences were here the primary character. The tribe Hordeae was divided into three groups, within each of which he discriminated genera of the " Agropyroid type ". In the tribe Hordeae he discriminated further seven sub-tribes, including the sub-tribe Brachypodieae. The phylogenetic congruity of this new system of the tribe Hordeae was soon substantiated by intergeneric and interspecific hybridization at the Plant Breeding and Genetic Station, Saratov, the Siberian Institute of Grain Husbandry, Omsk, and later elsewhere.

He made two other substantial contributions to the study of the Gramineae. He revised and commented on grasses in " Herbarium Florae Asiae Mediae " giving his own remarks and ideas, amounting in parts to a revision of almost entire genera (**23** and **24**) ; he compiled a valuable monograph on the genus *Hordeum* (**43**), which has now been left unpublished.

The interests and investigations of Nevskiĭ were not however confined to agrostology ; he investigated other plants, and contributed to " The Flora of U.S.S.R.", for which he wrote, in addition to the tribe Hordeae (**21**), parts of the Festuceae (**9, 10, 11, 12, 13, 14, 15, 16, 17, 18**) and the tribe Nardeae (**19**), also the tribe Leptureae (**20**), and partly on the families of Orchidaceae (**25**), Ranunculaceae (**37, 38**) and Polygalaceae (**44**). He also collaborated in the study and systematics of weeds (**26, 27, 28, 29**) and poisonous plants (**40, 41,** and **42**), parts of which have now been left unpublished.

Nevskiĭ was also interested in the history and origins of vegetation ; as a result of his participation in the expedition on the study of weed plants of Turkmenia in 1931, he published " materials on the flora of Kuhitang-tau and its foothills ", where he gave an original analysis of the genesis of the flora in this region of Central Asia (**36**).

It was only in 1935 that the Presidium of the Academy of Science in U.S.S.R. bestowed on him a scientific degree of the Candidate of Biological Science *honoris causa*. Nevskiĭ thus died on the threshold of what promised to be a brilliant scientific career.

Certain British botanists at the Royal Botanic Gardens, Kew, and elsewhere wish us to record their special appreciation of his enthusiasm and consistent readiness to maintain scientific relations and interchange of ideas and information with botanists interested in the taxonomy of grasses and related subjects in Great Britain.—M.A.O.

LIST OF WORKS OF S. A. NEVSKII

1. [On a new species in the genus *Agropyrum* Gaertn.] *Izv. Glav. Bot. Sada.* 29. 89-91. 1930. [German summary, 91].
2. [On certain representatives of the genus *Agropyrum* Gaertn.] *Izv. Glav. Bot. Sada.* 29. 536-42. 1930. [German summary, 542].

3. [Agrostological essays: 1. The species related to *Agropyrum strigosum* (M.B.) Boiss., and their distribution.] *Izv. Bot. Sad. Akad. Nauk SSSR.* 30. 489-508. 1932. [German summary, 508.]
4. [Agrostological essays: 2. On the species mixed with *Agropyrum longiaristatum* Boiss.] *Izv. Bot. Sad. Akad. Nauk SSSR.* 30. 508-17. 1932. [German summary, 517.]
5. [On the systematics of the genus *Agropyrum* Gaertn.] *Izv. Bot. Sad. Akad. Nauk SSSR.* 30. 607-35. 1932. [German summary, 635.]
6. [Agrostological essays: 3. *Clinelymus* (Griseb.) Nevski, novum genus Graminearum.] *Izv. Bot. Sad. Akad. Nauk SSSR.* 30. 637-52. 1932. [German summary, 652.]
7. [Botanical expeditions in Central Asia. Karljuk detail in Turkmenia.] [Contained in] *Exped. Vsesojuz. Akad. Nauk,* 1931. 166. 1932. Izd. Akad. Nauk, Leningrad.
8. [Agrostological essays: 4. On the system of the tribus Hordeae Benth.] *Trudy Bot. Inst. Akad. Nauk SSSR. Ser.* 1. No. 1. 9-32. 1933. [German summary, 28-32.]
9. Festuceae: *Sesleria* Scop. [Contained in] *Flora SSSR.* 2. 299-302. 1934. Izd. Akad. Nauk SSSR., Leningrad.
10. Festuceae: *Dupontia* R. Br. [Contained in] *Flora SSSR.* 2. 432. 1934. Izd. Akad. Nauk SSSR., Leningrad.
11. Festuceae: *Arctophila* Rupr. [Contained in] *Flora SSSR.* 2. 433. 1934. Izd. Akad. Nauk SSSR., Leningrad.
12. Festuceae: *Colpodium* Trin. [Contained in] *Flora SSSR.* 2. 434-45. 1934. Izd. Akad. Nauk SSSR., Leningrad.
13. Festuceae: *Catabrosa* P.B. [Contained in] *Flora SSSR.* 2. 445-6. 1934. Izd. Akad. Nauk SSSR., Leningrad.
14. Festuceae: *Phippsia* R. Br. [Contained in] *Flora SSSR.* 2. 446-8. Izd. Akad. Nauk SSSR., Leningrad.
15. Festuceae: *Lolium* L. [Contained in] *Flora SSSR.* 2. 545-52. Izd. Akad. Nauk SSSR., Leningrad.
16. Festuceae: *Psilurus* Trin. [Contained in] *Flora SSSR.* 2. 552-3. 1934. Izd. Akad. Nauk SSSR., Leningrad.
17. Festuceae: *Littledalea* Hemsl. [Contained in] *Flora SSSR.* 2. 553-4. 1934. Izd. Akad. Nauk SSSR., Leningrad.
18. [In collaboration with] V. B. Sočava. Festuceae: *Bromus* L.: subgenus *Zerna* (Panzer) Aschers. [Contained in] *Flora SSSR.* 2. 555-68. 1934. Izd. Akad. Nauk SSSR., Leningrad.
19. Nardeae Rchb. [Contained in] *Flora SSSR.* 2. 587. 1934. Izd. Akad. Nauk SSSR., Leningrad.
20. Lepureae Holmb. [Contained in] *Flora SSSR.* 2. 587-590. 1934. Izd. Akad. Nauk SSSR., Leningrad.
21. Hordeae Benth. [Contained in] *Flora SSSR.* 2. 590-728. 1934. Izd. Akad. Nauk SSSR., Leningrad.
22. [New data on the systematics of the genus *Colpodium* Trin.] *Bull. Moskovsk. Obšč. Ispyt. Prir.* 43 (2). 222-24. 1934. [German summary, 224.]
23. Schedae ad Herbarium Florae Asiae Mediae Fasc. XXI. *Trudy Sred.-Aziat. Univ. Ser. VIII b.* No. 17. 1-32. 1934.
24. Schedae ad Herbarium Florae Asiae Mediae. Fasc. XXII. *Trudy Sred.-Aziat. Univ. Ser. VIII b.* No. 17. 33-72. 1934.
25. Microspermae: Orchidaceae Lindl. [Contained in] *Flora SSSR.* 4. 589-730. 1935. Izd. Akad. Nauk SSSR., Leningrad.
26. [Compositae: the tribus Gundelieae.] [Contained in] *Sorn. rast. SSSR.* 4. 264-5. 1935. Izd. Akad. Nauk SSSR., Moskva-Leningrad.
27. [Compositae: the tribus Cynareae.] [Contained in] *Sorn. rast. SSSR.* 4. 265-307. Izd. Akad. Nauk SSSR., Moskva-Leningrad.

28. [Compositae: Liguliflorae.] [Contained in] *Sorn. rast. SSSR.* 4. 307-50. 1935. Izd. Akad. Nauk SSSR., Moskva-Leningrad.
29. Compositae. [Contained in the atlas] *Rasprostran. glav. sorn. rast. SSSR.* 1935. Izd. Akad. Nauk, Moskva-Leningrad.
30. [On the systematics of the genus *Triticum* L. On the account of the criticism on revision of the genus *Triticum* in Flora SSSR. 2. 1934.] 1935. *Sovet. Bot.* 6. 120-8.
31. [An inventory of grasses from the tribes Lolieae, Nardeae, Leptureae and Hordeae in the flora of U.S.S.R.] *Trudy Bot. Inst. Akad. Nauk SSSR.* *Ser.* 1. No. 2. 33-90. 1936. [German summary, 90.]
32. [What is *Listera savatieri* Maxim ?] *Trudy Bot. Inst. Akad. Nauk SSSR.* *Ser.* 1. No. 2. 107-20. 1936. [English summary, 119-20.]
33. Orchidaceae. [Contained in] *Schedis ad Herbarium Florae URSS.* Fasc. LXII. 23-36.
34. [Agrostological essays: 5. On the genus *Pentatherum* Nábělek and its species within the territory of U.S.S.R.] *Trudy Bot. Inst. Akad. Nauk SSSR.* Ser. 1. No. 3. 143-50. 1936. [German summary, 150.]
35. [*Hieracium pilosella* s.l. as an object for the study of clonal species.] *Sovet. Bot.* 2. 18-24. 1937.
36. [Materials on the flora of Kuhitang-tau and its foothills.] *Trudy Bot. Inst. Akad. Nauk SSSR.* *Ser.* 1. No. 4. 199-346. 1937. [German summary, 344-6.]
37. Ranunculaceae: *Delphinium.* [Contained in] *Flora SSSR.* 7. 99-183. 1937. Izd. Akad. Nauk SSSR., Moskva-Leningrad.
38. Ranunculaceae: *Thalictrum.* [Contained in] *Flora SSSR.* 7. 510-528. 1937. Izd. Akad. Nauk SSSR. Moskva-Leningrad.
39. [Conference on the history of flora and vegetation of U.S.S.R. Discussions on M. G. Popov's report.] *Sovet. Bot.* No. 2. 43. 1938.

Unpublished

40. Gramineae. [To be published in] "*Jadovit. rast. lugov i pastb. SSSR.*"
41. Ranunculaceae. [To be published in] *Jadovit. rast. lugov i pastb. SSSR.*
42. In collaboration with B. K. Šiškin. Euphorbiaceae. [To be published in] *Jadovit. rast. lugov i pastb. SSSR.*
43. [Materials on the study in wild-growing barleys with reference to the origin of *Hordeum vulgare* L. and *H. distichum* L. A monograph on the genus *Hordeum* L.] Manuscripts.
44. [Polygalaceae Linle in the flora of U.S.S.R.] Manuscripts.

Switzerland (494)

Federal Station of Agricultural Chemistry, Lausanne

A Report on the years 1931 to 1935 inclusive is presented by the Director, Dr. L. Tschumi, in *Landw. Jb. Schweiz.* 53. 751-70. 1939. A considerable proportion of the experimental work in the open was concerned with grassland. A report on the grassland of the Canton of Fribourg has already been published (see Tschumi and Stalé, *Herb. Abstr.* 5. 213. 1935). Successful results in the destruction of *Rosa Eglanteria* in the pastures of two localities were obtained from the use of a solution of calcium chlorate, injected into the root zone. Trials in concrete cases of one cubic metre capacity included experiments in the manuring of *Trifolium pratense.* Five years' employment of these cases demonstrated the impossibility of obtaining in them satisfactory cultures of certain plants, notably clovers and grasses, which suffer greatly from drought in spite of frequent watering.—G.M.R.

Federal Institute of Agricultural Chemistry, Liebefeld, Bern

The Report for 1938 is published by the Director, Dr. E. Truninger, in *Landw. Jb. Schweiz.* 53. 771-85. 1939. The number of grass and hay samples received for analysis was greater than in the previous year, and included material from farms on which pica had occurred. The chemical composition of meal from dried grass, clover and lucerne samples is tabulated.—G.M.R.

Canada (71)

Report of Minister of Agriculture

The report for the year ended March 31, 1939, contains details of the work of the Science Service, including the Divisions of Entomology, Botany and Plant Pathology and Chemistry, and of the Experimental Farm Service, including the Field Husbandry Division and the Division of Forage Plants. The work of the last two divisions was covered in *Herb. Rev.* 8. 21-4. 1940.

The transference of the other Divisions mentioned to the Science Service is the result of the reorganization of the Department of Agriculture.

Research in the Division of Botany and Plant Pathology is concerned with plant distribution, weeds and poisonous plants (including a detailed geographic and taxonomic study of *Agropyron*, distribution of ragweed as a major factor provocative of hay fever, pH reaction of lawn grasses in relation to the infesting weeds, respiration rates of seeds, etc.)

The Division of Chemistry covers the chemistry of plants, including analysis for composition of seeds, forage, etc. and studies of materials for sprays.—R.O.W.

Ontario Department of Agriculture

Reports have been received of the Ministry of Agriculture for the year ending March 31, 1939, and of the Agricultural and Experimental Union for 1938 (See *Herb. Rev.* 6. 155-7. 1938).—R.O.W.

National Research Council of Canada.

The twenty-second annual report is for the year 1938-39. Research in the Division of Biology and Agriculture includes studies on plant hormones, *Agropyron-Triticum* hybridization to produce a hardy, large-seeded, perennial forage plant for the drought areas, the use of colchicine in producing new heritable characters, and the growing of Marquis wheat plants at four temperatures and four light intensities to show how these weather factors interact on plant growth and affect adaptation.

More detailed information in the technical work of the laboratory division together with accounts of the work of the associate committees and investigators carried out under assisted researches in the universities is given in a Review of Activities of the National Research Council, 1938-39, obtainable from the National Research Council, Ottawa, price 75 cents.

Associate Committee on Weeds

The status and functions of this Committee were described by T. K. Pavlychenko in Bull 27 from this Bureau. Information has just been received stating that this Committee was reorganized once more at the end of 1939, on this occasion being brought under the auspices of the National Advisory Committee on Agricultural Services with the title of National Committee on Weeds. Dr. R. Newton, now Dean of the Faculty of Agriculture, University of Alberta, Edmonton, Alta., has been appointed Chairman of the reorganized Committee.—R.O.W.

U.S.A. (73)

Carnegie Institution of Washington

The Annual Report of the Chairman of the Division of Plant Biology is reprinted from the Carnegie Institution of Washington Year Book No. 38 for the year 1938-39, pages 107-41, issued Dec. 1938.

Detailed extracts from the previous report will be found in Bull. 26 from this Bureau, pp. 46-52.

State Agricultural Experiment Stations

The Reports for the States of Connecticut (New Haven—1938), Delaware (1939), Illinois (1936-37), Iowa (Part 1, 1939) and Missouri, (1937) have been received. With the exception of the first-mentioned State, the contents are a continuation of those noted in Bull. 26 from this Bureau. The Report from New Haven, Conn., contains little of pasture interest ; there is a reference on p. 41 to pasture soil studies.—R.O.W.

Brooklyn Botanic Garden

The *Brooklyn Botanic Garden Record* for April, 1940 contains the twenty-ninth annual report of the Garden for the year 1939. An account of the research in progress on plant pathology, systematics, breeding and genetics is given on pp. 51-69.—R.O.W.

Australia (94)

Commonwealth Prickly Pear Board

As it is considered that the necessary information on which the control of the pear might be based has now been obtained, it has been decided that the Board shall cease to function, leaving the execution of the actual measures of control to the State authorites concerned. Various recommendations were made at the last meeting of the Board in October, 1939, as follows.

(*a*) Staff.—The whole of the staff of the Board, except two officers who have resigned, will be taken over either by the Queensland or New South Wales authorities or by the Council.

(*b*) Future work.—The Council will continue overseas work on Noogoora burr. The States of New South Wales and Queensland will both continue the prickly pear work in their respective States and will collaborate with each other and with the Council.

(*c*) Queensland Weeds Committee.—Mr. A. P. Dodd is one of the officers taken over by the Queensland authorities ; he has been appointed to represent the Queensland Lands Department on the Council's Weed Committee.

(*d*) Disposal of assets.—The Council will take over the Board's assets overseas. The States of Queensland and New South Wales will take over the assets in their respective States.

(*e*) Publication of results—Arrangements are being made for the publication of a Bulletin.

(from *J. counc. Sci. Ind. Res. Aust.* 13. 60-1, 1940 ; see also article by A. P. Dodd in Bull. 27 from this Bureau).—R.O.W.

Economics of Soil Erosion in Victoria

J. A. Aird, Chief Irrigation Officer in the State of Victoria, attempts to assess the economic effect of erosion in the State, as measured by the damage or destruction of public works by wind and water (destruction of bridges, landslides, siltation and sedimentation etc.), and the loss of fertility and soil on wheat and grazing lands (Australasian, Melbourne, Mar. 2, 1940).

" It may be said that approximately, and most approximately, erosion causes a direct charge on the budget of £200,000 per year, and has caused a reduction in the production of the State of about £3,000,000 per annum, which has the effect of reducing the income of the State through taxation and other revenue by approximately £750,000, so that the cost to the State revenue is in the vicinity of £950,000, or in round figures £1,000,000 per annum."—R.O.W.

A. L. Tonnoir

We regret to announce the death on January 27, 1940, of Mr. A. L. Tonnoir, who was born in Brussels in 1885 (*Nature*, March 23, 1940) ; after working in various centres in New Zealand, Mr. Tonnoir joined the staff of the Division of Economic Entomology of the Australian Council for Scientific and Industrial Research. During the past ten years he has been closely associated with research on biological control of insect pests and weeds. A contribution on some insect pests of pastures in Australia will be found in Bull. 29 from this Bureau, pp. 44-5.—R.O.W.

Hawaii (969)

Hawaii Agricultural Experiment Station

The Annual Report for 1939, issued March, 1940, contains reports of research on agronomy and plant physiology, among other subjects.

Agronomy. Introduction of forage and pasture species from tropical and subtropical countries determining adaptability and growth characteristics of the introductions at four localities ; testing desirable species for palatability and forage value ; and an ecological survey of distribution of grasses and shrubs throughout the Territory, with a classification of agricultural lands into climatic zones.

Plant physiology. Study of the factors affecting germination of the seed pieces of sugarcane ; determination of the arsenic tolerance of Sudan grass, tomato, and bush bean ; and treatment of seeds with various substances to increase germination.—R.O.W.

SEED EXCHANGE

Tokyo, Japan

Seeds offered from the 1940 collection of the Botanical Garden, Imperial University, Tokyo, Japan.

Gramineae

Agropyrum semicostatum Nees
Agrostis nebulosa Boissier et Reuter
Alopecurus geniculatus Linnæus
Andropogon Goeringii Steudel
A. brevifolius Swartz
Anthoxanthum odoratum Linnæus
Arthraxon hispidus Makino
Arundinella hirta Tanaka var. *ciliata* Koidzumi
Arundo Donax Linnæus
A. Donax var. *variegata hort.*
Avena sativa Linnæus

Briza maxima Linnæus
B. minor Linnæus

Calamagrostis sciurioides Franchet et Savatier
Coix agrestis Loureiro
C. Lacryma-Jobi Linnæus
Cortaderia argentea Stapf

Dactylis glomerata Linnæus

Eccoilopus cotulifer A. Camus
Echinochloa crus-galli P. Beauvois var. *submutica* Nakai
E. frumentacea Link.
Eleusine indica Gærtner
Eragrostis ferruginea P. Beauvois
E. Niwahokori Honda

Festuca pratensis Hudson

Hakonechloa macra Makino
Hordeum vulgare Linnæus

Imperata cylindrica P. Beauvois var. *Koenigii* Durand et Schinz
Isachne globosa O. Kuntze
Ischaemum anthephoroides Miquel var. *eriostachyum* Honda
I. crassipes Thellung var. *typicum* Nakai
Koeleria gracilis Persoon var. *tokiensis* Honda
Miscanthus sacchariflorus Andersson
M. sinensis Andersson
M. sinensis var. *gracillimus* Hitchcock
M. sinensis var. *variegatus* Hitchcock
M. sinensis var. *zebrinus* Matsumura
M. tinctorius Hackel
Melica nutans Linnæus

Oplismenus undulatifolius Roemer et Schultes
Oryza sativa Linnæus
O. sativa Linnæus var. *atropurpurea hort.*

Paspalum Thunbergii Kunth
Pennisetum japonicum Trinius
P. orientale Richard var. *triflorum* Stapf
Phaenosperma globosa Munro
Phleum pratense Linnæus
Poa annua Linnæus
P. compressa Linnæus
P. pratensis Linnæus
Pogonatherum crinitum Trinius
Polypogon Higegaweri Steudel

Sacciolepis oryzetora Honda
Setaria viridis P. Beauvois var. *genuina* Honda
Sorghum japonicum Roshevitz
S. japonicum var. *transiens* (Honda)
Spodiopogon sibiricus Trinius
Sporobolus elongatus R. Brown.
Syntherisma Ischaemum Nash
S. sanguinalis Dulač

Themeda japonica Tanaka
Triticum aestivum Linnæus

Zea Mays Linnaeus
Z. Mays var. *variegata hort.*
Zoysia japonica Steudel

Leguminosae

Amorpha fruticosa Linnæus
Astragalus sinicus Linnæus

Baptisia australis R. Brown

Cassia laevigata Willdenow
C. Nomame Siebold
C. Tora Linnæus
Clitoria ternatea Linnæus

Desmodium capitatum A. P. de Candolle
D. Oldhami Oliver
D. racemosum A. P. de Candolle

Erythrophleum Fordii Oliver

Hedysarum elongatum Fischer var. *albiflorum* Ledebour

Indigofera Kirilowii Maximowicz
I. pseudotinctoria Matsumura

Lathyrus Davidii Hance
L. japonicus Willdenow
L. latifolius Linnæus
Lespedeza bicolor Turczaninow var. *japonica* Nakai
L. Buergeri Miquel
L. cuneata G. Don
L. japonica Bailey var. *albiflora* Nakai
L. nipponica Kakai
L. Thunbergii Nakai
Lotus corniculatus Linnaeus var. *japonicus* Regel
Lourea Vespertilionis Desvaux

Lupinus luteus Linnæus
L. nanus Douglas var. *albococcinea hort.*
L. perennis Linnæus

Maackia Buergeri Nakai
Melilotus coerulea Desrousseaux

Phaseolus vulgaris var.
Pisum sativum Linnæus
Pterocarpus carolinensis Kanehira
Pueraria Thunbergiana Bentham

Scorpiurus muricatus Linnæus
Styphnolobium japonicum Schott

Thermopsis fabacea A. P. de Candolle

Vicia Faba Linnæus
V. hirsuta Koch
V. nipponica Matsumura
V. unijuga Al. Braun

Wistaria floribunda A. P. de Candolle
W. floribunda var. *rosea* Bailey

IMPORTS OF FORAGE PLANT SEEDS INTO THE UNITED STATES.

(Reported by Agricultural Marketing Service, U. S. Department of Agriculture)

[Information similar to that quoted below from *Seed World*, 47. 21. 1940, appears from time to time in that publication, which is published bi-monthly on Fridays for North American dealer-distributors of seeds and other agricultural and horticultural supplies by the Seed Trade Reporting Bureau, Inc., 223, West Jackson Boulevard, Chicago, Ill., U.S.A.]

Permitted entry into the United States under the Federal Seed Act

Kind of Seed	February 1 to 15 1940 pounds		July 1, 1939 to February 15, 1940 pounds
Alfalfa	457,300	(1)	2,137,300
Bluegrass, Canada	3,900	(2)	17,700
Brome, smooth	299,800	(2)	2,526,300
Clover, alsike	....	(2)	374,300
Clover, crimson	....	(3)	5,051,200
Clover, red	44,000	(4)	81,100
Clover, white	7,000	(5)	613,500
Fescue, meadow	....	(6)	24,900
Grass, orchard	35,300	(7)	276,000
Mixtures, alfalfa and timothy	....	(2)	15,900
Mixtures, alsike and timothy	....	(2)	34,300
Mixtures, grass	....	(8)	34,500
Rape, winter	....	(9)	4,427,200
Ryegrass, Italian	1,500	(10)	292,200
Ryegrass, perennial	53,000	(11)	601,500
Timothy	300	(12)	600
Vetch, common	....	(13)	249,000
Vetch, hairy	7,600	(14)	2,619,000

(1) 1,747,100 pounds from Canada; 390,000 pounds from Argentina; 200 pounds from Australia.

(2) From Canada.

(3) 2,923,600 pounds from France (115,400 pounds of Hungarian origin); 1,818,900 pounds from Hungary; 230,800 pounds from Germany (of Hungarian origin); 55,000 pounds from Poland; 22,900 pounds from Great Britain (900 pounds of French origin).

(4) 33,000 pounds from Rumania; 4,100 pounds from Canada; 44,000 pounds from France.

(5) 297,100 pounds from Poland; 254,700 pounds from Hungary; 36,200 pounds from New Zealand; 17,400 pounds from Great Britain; 7,500 pounds from Japan; 600 pounds from Australia.

(6) From Denmark.

(7) 252,200 pounds from Denmark; 22,400 pounds from Japan; 800 pounds from Great Britain; 500 pounds from New Zealand (300 pounds of Australian origin); 100 pounds from Australia (of New Zealand origin).

(8) 33,900 pounds from Canada; 600 pounds from Great Britain.

(9) 3,093,800 pounds from Japan; 396,400 pounds from Great Britain (of Rumania origin); 288,700 pounds from Switzerland (of Rumanian origin); 235,000 pounds from Rumania; 208,800 pounds from Hungary; 204,500 pounds from the Netherlands (105,500 pounds of Hungarian origin).

(10) 281,200 pounds from Argentina ; 5,300 pounds from New Zealand ; 4,200 pounds from Australia (100 pounds of New Zealand origin) ; 1,500 pounds from Northern Ireland.

(11) 296,600 pounds from Great Britain (218,700 pounds of Northern Irish origin ; 77,900 pounds of Northern Irish and Danish origin) ; 280,800 pounds from Northern Ireland ; 19,700 pounds from Denmark ; 2,200 pounds from Australia (100 pounds of New Zealand origin) ; 2,200 pounds from New Zealand.

(12) 500 pounds from Canada ; 100 pounds from Great Britain.

(13) 160,900 pounds from Rumania ; 88,000 pounds from Latvia ; 100 pounds from Great Britain.

(14) 2,441,600 pounds from Hungary ; 103,000 pounds from Latvia ; 66,800 pounds from Sweden ; 7,600 pounds from Canada.

Not subject to the Federal Seed Act.

Kind of Seed	February 1 to 15 1940 pounds	July 1, 1939 to February 5, 1940 pounds.
Bentgrass	....	121,200
Bluegrass, annual	....	4,100
Bluegrass, rough	....	730,500
Bluegrass, wood	....	2,900
Clover, subterranean	....	900
Clover, suckling	....	34,700
Dogtail, crested	....	11,700
Fescue, Chewings	6,500	748,700
Fescue, other	12,200	100,400
Grass, Bahia	....	43,900
Grass, Dallis	....	80,700
Grass Guinea	....	57,800
Grass, Jaragua	2,300	5,900
Grass, molasses	4,200	46,200
Grass, rescue	....	200
Grass, Rhodes	....	88,400
Grass, velvet	....	7,400
Kudzu	....	5,000
Medick, black	....	107,200
Millet, Japanese	108,800	633,700
Sourclover	....	35,000
Sweetclover	104,300	3,288,900
Trefoil, big	....	700
Trefoil, birdsfoot	....	500
Vetch, purple	....	1,000
Wheatgrass, crested	37,400	933,600
Wheatgrass, slender	....	30,800
Yarrow, common	....	500

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IMPERIAL BUREAU OF PASTURES AND FORAGE CROPS

This Bureau covers literature on grassland and forage crops, the botanical aspects of soil conservation, and certain plant biological research. It issues two quarterly journals:

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BULLETIN No. 26, PUBLISHED SEPTEMBER, 1939

"Research on grassland, forage crops and the conservation of vegetation in the United States of America"

Pages: 113, maps, indexes of subjects and genera. Price: Five shillings.

BULLETIN No. 27, PUBLISHED JANUARY, 1940

"The control of weeds"

(A symposium on current research and practice in the eradication of undesirable plants in arable land, grassland, etc., by cultural, chemical and biological means.)

Contributions by: T. K. Pavlychenko and R. H. F. Manske (Canada); L. W. Kephart, A. S. Crafts, R. N. Raynor, and J. Monteith, Jr. (U.S.A.); B. Rademacher (Germany); G. A. Currie and A. P. Dodd (Australia); E. Bruce Levy and D. Miller (New Zealand); D. G. Steyn (South Africa).

Pages: 168. Fully illustrated. Price: Seven shillings and sixpence.

BULLETIN No. 28, PUBLISHED JANUARY, 1940

"Technique of grassland experimentation in Scandinavia and Finland"

Contributions by: G. Giöbel and K. Lundblad (Sweden); B. Sakshaug and H. Foss (Norway); H. Bögh and J. Hansen (Denmark); C. A. G. Charpentier (Finland).

Pages: 52. Price: Two shillings and sixpence.

BULLETIN No. 29, PUBLISHED JANUARY, 1940

"Grassland investigations in Australia"

(This Bulletin gives notes on the work of institutions engaged in grassland research, followed by a series of special articles on the Australian environment, plant introduction, plant breeding and selection, northern and southern Australian pastures, and weeds and insect pests. Special articles are also devoted to the pasture investigations in the State Departments of Agriculture and at the Waite Institute. The final part contains 247 abstracts on grassland in Australia.

Pages: 107, maps, index of genera. Price: Five shillings.

IMPERIAL AGRICULTURAL BUREAUX,
JOINT PUBLICATION No. 3, MARCH, 1940

Published by the Imperial Bureaux of Pastures and Forage Crops, and Plant Breeding and Genetics.

"The breeding of herbage plants in Scandinavia and Finland"

(A symposium including details of the most recent improved strains of grasses, clovers and lucerne, and the methods used in producing them, as well as a contribution on the application of cytology to herbage plant breeding.)

Contributors: G. Nilsson-Leissner, F. Nilsson, E. Åkerberg, and R. Torssell (Sweden); H. N. Frandsen (Denmark); H. Wexelsen (Norway); O. Pohjakallio (Finland).

Pages: 124. Price: Four shillings.

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IMPERIAL BUREAU OF PASTURES AND FORAGE CROPS

(See inside back cover)

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